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ABSTRACT

A model curriculum for an associate of applied science degree in chemical operations technology (COT) was developed at Texas State Technical College in Marshall, Texas. First, a comprehensive analysis of the local and statewide labor market demand for trained personnel in the advanced field of COT was conducted. Next, a comprehensive task analysis was performed, and the competencies required for COT were identified. The competencies were incorporated into an associate degree-level COT curriculum that includes competencies in the areas of statistical process control and process safety management and courses in the following topics: general chemistry, composition, computer applications, college algebra, interpersonal communications, critical thinking and problem solving, plane trigonometry, basic statistics, instrumentation and control, college physics, environmental health, chemical processes and process equipment operations, plant operations and systems, and process operations safety. The curriculum and curriculum handbook were developed in both 4-semester and 6-quarter formats for use by all two-year colleges throughout Texas. (Appended are the following: project advisory committee list and minutes; industrial needs and competency analysis survey results; list of companies surveyed; curriculum and course descriptions for quarter and semester formats; and competencies and courses matrix. The curriculum materials are also included.) (MN)

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ED 395 175

Project #55110005

Chemical Operations Technology - Curriculum Development Project

Texas State Technical College - East Texas Center

PY95 Final Detailed Report on:

Chemical Operations Technology

Curriculum Development Project

August 1995

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ACKNOWLEDGEMENTS

The project staff expresses gratitude to the following persons from industrial and educational organizations in Texas who contributed greatly to the completion of this project by participation as members of the Project Advisory Committee:

Bill Hansen - Texas Eastman - Texas Division of Eastman Chemicals, Longview

Richard Coleman - Huntsman Chemical Corp., Pasadena

Dale Anna - Occidental Petrochemical, Dallas

David Waite - Atlas Processing Co. - Shreveport

Bruce Clements - Lyondell Petrochemicals, Channelview

Bill Railey - College of the Mainland, Texas City

The support and assistance of Texas State Technical College - East Texas Center administration in persons of Dr. Jack Foreman, Dean, Dr. John Carnes, Assoc. Dean of Instruction, and Ms. Jeanne Wesley, Grants Director, is appreciated as well.

TEXAS HIGHER EDUCATION COORDINATING BOARD
PY 95 END OF REPORT
JULY 1, 1994 - JUNE 30, 1995

EXECUTIVE SUMMARY

Texas State Technical College - Marshall
Institution

55110005
Project Number

PROJECT TITLE: Chemical Operations Technology - Curriculum Development
PROJECT DIRECTOR: Alex Kajstura

1. Purpose of the project:

To develop a model curriculum for the Associate of Applied Science Degree in Chemical Operations Technology in both four-semester and six-quarter format, with inclusion of Statistical Process Control and Process Safety Management competencies.

2. Summary of Goals and Objectives Accomplished:

Objective A: A comprehensive analysis of the local and statewide labor market demand for trained personnel in the advanced field of Chemical Operations Technology (COT) has been conducted. The Project Advisory Committee was formed to coordinate this effort.

Objective B. A comprehensive task analysis was conducted and competencies required for COT were identified. Program objectives were stated as occupational competencies and/or skill and knowledge requirements and were based on results of comprehensive task surveys. Related occupational competencies were grouped into courses.

Objective C. The curriculum has been developed. It includes course descriptions, course sequence, weekly lecture and laboratory hours, contact hours, and credit hours for all courses. This curriculum was developed in both the semester and quarter formats for potential use by any two-year college in the State.

SUBCONTRACTORS: none

CONSULTANTS: William Hansen

COORDINATING AGENCIES: none

PRODUCTS: Curriculum Handbook

CHEMICAL OPERATIONS TECHNOLOGY

FINAL REPORT

Overview

Texas State Technical College - East Texas Center was awarded a Carl D. Perkins Grant by the Texas Higher Education Coordinating Board to develop the curriculum for the high-tech, high-demand, high-pay chemical operations technology, focused on the continuous process control and maintenance in chemical, petrochemical, and related industries. The results of this project will be made available to all public two-year colleges in texas through this final report.

Chemical Operations Technology is gaining rapidly the attention of two-year colleges in Texas. Within the last two years work has been done by Texas State Technical College - East Texas Center in collaboration with Texas Eastman Division of Eastman Chemicals to implement such program. Actually, one month before this Perkins Grant was awarded, Texas State Technical College - East Texas Center was approved by the Texas Higher Education Coordinating Board to implement Chemical Operations Technology as an option in the Chemical Technology Program. Texas State Technical College - East Texas Center is the only location at TSTC System offering such a program. Implementation of such a program and curriculum development work is in agreement with the Mission of the TSTC Waco/Marshall, which states that "*TSTC System shall contribute to the educational and economic development of the state of Texas by offering specialized advanced and emerging technical (....) associate degrees. (....) In developing and offering highly specialized technical programs with related supportive coursework, primary consideration should be placed on industrial and technological manpower needs of the state. The emphasis of each TSTC System campus shall be on advanced or emerging technical programs (...).*"

Introduction

Chemical operators are very vital part of staff in any chemical, petrochemical, or related industry. They are the individuals directly involved in controlling the process in a plant, assuring both the quantity as well as quality of chemical product(s) at their facility. Additionally, their jobs require an absolute commitment to the safety issues and the continuous attention to these. Chemical, petrochemical, and related industries contribute greatly to the quality of our lives, progress of the civilization, and occupy significant place in the picture of U.S.A. as an industrial country. Texas is a state that has one of the largest numbers of chemical, petrochemical, and related industry facilities, and their impact on economy of the state is significant. Until recently, the companies were tasking care of their training needs themselves. This training ranges from traditional on-the-job training, where the prospective operators would learn from experienced ones by following them around, to a nationally recognized, Department-of-Labor-certified apprenticeship program with very rigorous evaluation. While most of the chemical, petrochemical, and related industries are located in the greater Houston area, the second largest chemical manufacturer in the state, Texas Eastman, is located in Longview, about twenty miles west of Texas State Technical College - East Texas Center.

Background

The term "Chemical Operations" is applicable to a large number of industry categories that use chemical processes to transform one or more type of chemicals into another, chemically and physically different product(s). The chemical industry is the largest of all industries utilizing such value-added manufacturing processes. Among manufacturing industries in the U.S., the chemical industry occupies fourth position, and provides about six percent of all manufacturing jobs at wages about one-third above the manufacturing average. In 1991, the sales of chemical industry were about $290 billion and had a positive impact on the U.S. trade balance at $18.8 billion, making American chemical manufacturing a real world power.

One of the factors well recognized for decades and often mentioned while dealing with highly qualified workforce, is that not only any manufacturing company would be prone to expand by building new facilities or moving its operations to a state with highly qualified workforce. In today's global economy a potentially more dangerous phenomenon is emerging slowly, and many chemical process industry companies could become affected by it, since they are either subsidiaries of foreign companies or have sites abroad. They consider many factors when making decisions about expanding, closing, or establishing employment sites, including the quality of workforce. Assuring that highly-qualified, well-trained chemical operations workers are available may encourage decisions favorable to U.S. sites.

Chemical process industries in the United States tend to be highly concentrated in several geographical areas. According to the American Chemical Society, almost every larger community has some individuals whose work assignments qualify them as chemical process technical workers. Chemical process technical workers are often concentrated by the chemical process companies in very large numbers. However, some of them may be assigned to highly independent work assignments at customer locations or at remote sites.

The workers who undergo the type of training considered here will work under a variety of generic titles such as technician, technologist, operator, process operator, pilot plant operator, chemical engineering technician, etc. In this document, they are referred to as "chemical operators."

Chemical operators are related regardless of their title by the fact that they engage in modifying or manipulating the chemical properties of materials. The quantities of chemical substances they handle each may vary from relatively small to thousands of pounds. They may handle new materials and extremely toxic chemicals. Some of them control multimillion dollar systems, often handling enormous quantities of potentially hazardous materials. all of them must be acutely sensitive to the hazards of the materials

they handle and the fate of all waste streams as well as of the product.

Similarities described above require all chemical operators to have similar fundamental skills and knowledge. However, the chemical operators also require a variety of highly specialized, site-specific, and process-specific skills to perform individual assignments effectively. This curriculum design project identifies the important skills and knowledge required of entry-level chemical operators.

The broad definition of the chemical operator encompasses about 500,000 workers in the U.S. The current chemical operations workforce in many areas is very mature, and many replacements will be needed within the next five years. Data demonstrate that few current chemical operators were trained specifically for the type of job they hold. Currently, many chemical operators are college dropouts from programs designed for scientists and engineers, or college graduates who couldn't find a job in their fields, or couldn't secure decent standard of living with jobs they found in their fields. Many chemical operators have completed only high school and have weak background in math and physical sciences. Despite such diverse backgrounds, these chemical operators have the responsibility levels and skill requirements that are critical to ensuring the future competitive positions of many companies.

Project Objectives

The objectives for this curriculum development project were listed in three groups:

A. To conduct comprehensive analysis of the local and the statewide labor market demand for trained personnel in the advanced field of Chemical Operations Technology (COT), requiring an Associate of applied Sciences degree. To identify priorities in specialized areas within COT. To establish a Project Advisory

Committee to coordinate this effort.

B. To conduct a comprehensive task analysis representative of local and statewide needs, and to determine the skills and knowledge requirements for COT. To develop and validate the program purpose and objectives. Program objectives shall be stated as occupational competencies and/or skill and knowledge requirements and shall be based on results of comprehensive task surveys. Related occupational competencies shall be grouped into courses.

C. To develop a curriculum. It may include courses from an existing program, and will include course descriptions, course sequence, weekly lecture and laboratory hours, contact hours, and credit hours for all courses. This curriculum is to be developed in both the semester and quarter formats for potential use by any two-year college in the State.

Methodology

The project activities consisted of three parts related to the objectives stated above: (1) conducting a needs assessment, (2) conducting a task analysis, and (3) developing a curriculum. Formation of a project Advisory Committee was a prerequisite for successful completion of such activities. The role of this committee was to (1) contribute professional expertise during the needs assessment as well as task analysis part of the project, (2) provide expert feedback during evaluation of each part of the project, and (3) review, validate, and analyze the findings, results, and conclusions of this curriculum development project.

The initial activities of the project consisted of discussing the results of previously conducted research into the issues and needs in the area of Chemical Operations Technology, meeting with and/or conducting phone interviews with professionals and experts in the chemical operations field including industry experts and chemical

operations training specialists. The purpose of these activities was to identify a pool of potential Project Advisory Committee members, gather preliminary information regarding priority areas of chemical operations technology, trends in chemical and process industry, a preliminary list of skills and knowledge required, as well as to provide more comprehensive data about the employment opportunities. This information was used to develop a survey instrument which subsequently was refined during the first Project Advisory Committee meeting.

This second part of the project utilized the results of the needs assessment to develop and conduct a mail survey to be distributed to a large population of industries that were employers of chemical operations technicians. The purpose of this survey was to determine the skills and knowledge requirements for Chemical Operations technicians. The results of the survey were compiled, analyzed, and conclusions were drawn concerning curriculum. This information was made available to all members of the Project Advisory Committee in the second meeting. Subsequently, the Project Advisory Committee reviewed these responses, and provided comments and suggestions regarding their implementation in the curriculum.

With the findings of the second part of this project, the curriculum for Chemical Operations Technology was developed. Tasks and competencies were listed, developed into learning objectives, grouped into logical sets and sequences, and correlated into courses. Course descriptions were developed and courses were sequenced as appropriate. Existing academic and technical courses in programs such as Chemical Technology and others were used where necessary or appropriate in the development of Chemical Operations Technology. The Project Advisory Committee provided expert feedback and evaluation of the first draft of this curriculum, resulting in a more complete and refined product.

Preliminary Findings

The process of selection of the Project Advisory Committee was utilized to determine support for this kind of a project as well as the needs. In the process, individuals from chemical and related industries, as well as higher education institutions were contacted and either telephone or personal conversations with them verified the need for such a project.

Information obtained during this process pointed towards great diversity currently in how employers accomplish appropriate training for their chemical operators, what are their expectations of prospective chemical operators, what are employers expectations of training provided by two-year colleges, and what level of training would be appropriate if done by colleges.

In conclusion, these discussions proved the chemical and related industries' trend to expect new chemical operators (as well as all new entry-level employees) to have an Associate of Applied Science degree in a program specifically preparing them for chemical operator's duties, giving them both required job-specific technical skills based on a solid foundation of science and mathematics, as well as more general interpersonal skills.

Project Advisory Committee

The Project Advisory Committee's first meeting was designed to present the information gathered up to date. Because of the extensive interaction between the individuals who accepted participation on this committee and the project staff, besides seeking the input and guidance from the Project Advisory Committee, this committee evaluated and provided feedback for the Industry Needs Survey.

The following general activities were accomplished during the first Advisory Committee

meeting:

1) Members of the committee participated in a general, comprehensive orientation regarding the nature of this project. Background of related activities at Texas State Technical College - East Texas Center, and summary of preliminary visits and conversations was presented as well.

2) The Industrial Needs Survey prepared by the project staff was reviewed by the members of the committee. Discussion has taken place regarding phrasing of some items and completeness of the survey, resulting in some changes in questions, and choices of answers in multiple choice questions. The committee approved the mailing of this survey after changes recommended were made.

3) The committee also became acquainted with existing chemical operator training programs in two-year colleges. Information on these programs was acquired during visits by the project staff at several colleges, and resulted in data on programs ranging from 96 clock hours to two-year Associate of Applied Science.

Following this first meeting of Project Advisory Committee, the Industry Needs Survey (appendix C) was revised based on the feedback, and the mailing has been sent to chemical, petrochemical, and related industries in and out of the state. As the returns were coming in, the results were being compiled for presentation to the committee during the second meeting and for the inclusion in the final report as a document on which further work was based.

The following general activities were accomplished during the second advisory committee meeting:

1) The committee became acquainted with the preliminary results of the Industry Needs Survey compiled by the project staff. Based on the information obtained in the questions # 6 and 7 in this survey, the project staff prepared and presented a

comprehensive list of competencies to the committee for evaluation, additions, and deletions.

2) Most of the second meeting was dedicated to the evaluation of this competency list with the understanding that its completeness was critical for obtaining proper feedback from industry. By the end of the meeting recommended changes were agreed upon and recorded, and the format of the Competencies Analysis Survey was approved by the committee.

3) The members of committee were also presented information on the THECB's guidelines for technical education and how these guidelines would impact the shape of the curriculum. Questions from the committee and discussion helped clarify some issues, including but not limited to understanding the role of general education courses, cooperative training, and electives.

Following the second meeting and recommended revisions, the Competencies Analysis Survey was mailed to the same companies that received the first mailing. As the first responses began arriving, the project staff initiated arranging competencies into courses in both semester as well as quarter format. These were to be presented during the last meeting of the Project Advisory Committee.

The following was accomplished at the third Project Advisory Committee meeting:

1) General information about developments in the grant was presented to the advisory committee. The final results of the Competencies Analysis Survey were presented to the committee for evaluation, comments, and possible clarification.

2) The draft of conversion and grouping of these competencies into six-quarter and four-semester curricula was presented for the discussion. This part of the meeting took up the remainder of time allocated for the meeting, as it was to be the last meeting of the committee.

3) One of the major recommendations that came up during the meeting and subsequently became incorporated into the curriculum was the issue of cooperative

education. Agreement has been reached that the best way to incorporate co-op into a degree plan is in the form of an elective.

Mail Survey Process

Two surveys by mail have been done as a part of this project. Both surveys were mailed to the same two hundred companies. The names and locations of the companies were identified using the 1993 Directory of Operator Qualification and Certification Seminar, and 1992 Directory of Texas Manufacturers. The following categories were considered from the 1992 Directory of Texas Manufactures: (1) Natural Gas Liquids, (2) Manufacturing Industrial Inorganic Chemicals, (3) Plastics Materials & Synthetic Resins, Synthetic Rubber, Cellulosic and other Man-Made Fibers, (4) Drugs, (5) Paints, (6) Industrial Organic Chemicals, (7) Miscellaneous Chemical Products, and (8) Petroleum Refining. In both cases, after a period of three weeks, a second mailing was sent to these companies who did not respond the first time. This approach allowed to accomplish a valid response rate for both surveys.

The first survey mailed was the Industry Needs Survey which had a twofold purpose of: (a) verifying the need and employment opportunities for chemical operators with Associate of Applied Sciences degree, and (b) verifying skills expected of chemical operators in a workplace. The return rate of valid responses from this survey was 60.5%. Results of this survey are enclosed in the Appendix C.

The second survey was the Competencies Analysis Survey. Its purpose was to rank the comprehensive list of competencies established as a result of work done by the project staff and the Project Advisory Committee. The return rate of valid responses from this survey was 55.0%.

Summary and Conclusions of Survey Results

The Industry Needs Survey response data indicated that chemical and related industries have very strong need for highly qualified technicians at this time. Over 50% companies indicated that, based on the current trends they may hire twenty or more chemical operators in the next two years. This means that the companies participating in this survey may be able to hire as many as one thousand operators in the next two years. Very positive response was given to the knowledge areas listed in the survey; over 85% of responses to each item required excellent or very good theoretical understanding and/or hands-on experience.

Possibly the most important data from this survey is contained in the responses to questions about (1) industries preference for a chemical operator with an Associate of Applied Science degree, and (2) the salary range. The 90% of respondents indicated they would prefer to hire a chemical operator with an Associate of Applied Science degree. The entry salary range indicated was from $21,000 to $42,000 per year.

Even without making any extrapolation, it is evident that there are significant job opportunities for chemical operators who have acquired their knowledge in a technical program granting an Associate of Applied Science degree. Apparently this degree must be a result of a well designed curriculum. The Competencies Analysis Survey enabled this project staff and the Project Advisory Committee to design such curriculum. The Competencies Analysis Survey indicated very strongly that chemical and related industries expect of chemical operators to have a very good math and physical science foundation as well as good understanding of processes, their control, equipment and systems in chemical plants. But it is equally important for a chemical operator in a modern chemical industry to have a thorough understanding of the role and applications of the Statistical Process Control and well as safety issues and regulations, including the Process Safety Management. Interpersonal skills and the ability and willingness to work as a member of a team were ranked very highly Complete results from both surveys are

found in Appendix C. The Appendix D provides curricula for both semester and quarter systems developed based on the comprehensive list of competencies obtained and verified as a result of the Competencies Analysis Survey. Appropriate course descriptions with numbers of lecture, laboratory, and credit hours are presented as well.

CHEMICAL OPERATIONS TECHNOLOGY

APPENDIX A

1. Project Advisory Committee Members List
2. Minutes of the Advisory Committee Meetings.

APPENDIX A

1. Project Advisory Committee Members List

Dale Anna
Manager Operations Training
Occidental Chemical Corporation
Corporate Office
P.O. Box 809050
Dallas, TX 75380

Bruce Clements
Operations Supervisor
Lyondell Petrochemicals
8280 Sheldon Rd.
Channelview, TX 77530

Richard Coleman
Training Director
Huntsman Chemcial Corporation
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Pasadena, TX 77507

William Hansen
Supervisor Operations Training
Texas Eastman Co.
P.O. Box 7444
Longview, TX 75607

William Railey
Dean
College of the Mainland
1200 Amburn Rd.
Texas City, TX 77591

Sandra Slider
Training
West Vaco Chemicals
P.O. Box 836
Derider, LA 70634

David L. Waite
Training Coordinator
Atlas Processing Company
3333 Midway Street
Shreveport, LA 71133

APPENDIX A

2. Minutes of the Advisory Committee Meetings.

Chemical Operation Technology - Curriculum Development

Carl Perkins Grant

Minutes of the Project Advisory Meeting:

Date: October 15, 1994

Advisory Committee Members:

Bill Hansen - Texas Eastman - Texas Division of Eastman Chemicals, Longview

Richard Coleman - Huntsman Chemical Corp., Pasadena

Dale Anna - Occidental Petrochemical, Dallas

David Waite - Atlas Processing Co. - Shreveport

Bruce Clements - Lyondell Petrochemicals, Channelview

Bill Railey - College of the Mainland, Texas City

Sandra Slider - West Vaco, Derider

Present at the meeting:

Bill Hansen - Texas Eastman - Texas Division of Eastman Chemicals, Longview

Richard Coleman - Huntsman Chemical Corp., Pasadena

Dale Anna - Occidental Petrochemical, Dallas

Bruce Clements - Lyondell Petrochemicals, Channelview

Alex Kajstura - Texas State Technical College

Karen Buchert -Texas State Technical College

David Cole - TSTC

Clyde Ford - TSTC

This meeting was began by Dr. Carnes , the associate dean of instruction at TSTC - East Texas Center, who welcomed all participants and thanked them for the willingness to participate in this very important project. Dr. Carnes indicated that, as a prime technical college, TSTC-ETC has a responsibility and vested interest to conduct projects like this one, leading to establishment of top-notch curricula for high-demand, high-pay technical programs.

Introductions of all the present members of the Project Advisory Committee, as well as project staff, followed. Each person described his/her position, responsibilities, and the company they worked for.

Next, Dr. Kajstura presented the history of chemical technology program development, the chain of events that led to establishment of the Chemical Operations option at TSTC-ETC in Sept. 1994, and an overview of the Carl Perkins Curriculum Development grant the college received in June 1994 to create a model curriculum leading to an Associate of Applied Science in Chemical Operations. He presented future development plans for TSTC as well, including a new modern facility that would house chemical technology programs as well. Dr. Kajstura presented also findings that were results of his preliminary conversations and visits with colleges in Texas that already had some form

of training programs for chemical operators established. In particular, visits to and programs at (1) Lamar Technical Institute, Beaumont, (2) San Jacinto College, Pasadena, and (3) College of the Mainland, Texas City, were described with the assistance from Bill Hansen who participated on these trips.

In the following activity, the draft of Industrial Needs Survey was distributed to all present, and review of the document followed. Dr. Ford explained how the instrument was created and comments were received from participants, resulting in few changes of questions. Eventually, the members of the committee agreed that the instrument was ready to be sent to the participating companies. Dr. Kajstura explained to the committee the mailing survey process as well as the origin of mailing lists, and received an approval to process with the mailing.

Following this activities, all meeting participants were invited to the lunch, during which a lively informal discussion was expected to occur.

Chemical Operation Technology - Curriculum Development

Carl Perkins Grant

Minutes of the Project Advisory Meeting:

Date: March 10, 1995

Advisory Committee Members:

Bill Hansen - Texas Eastman - Texas Division of Eastman Chemicals, Longview

Richard Coleman - Huntsman Chemical Corp., Pasadena

Dale Anna - Occidental Petrochemical, Dallas

David Waite - Atlas Processing Co. - Shreveport

Bruce Clements - Lyondell Petrochemicals, Channelview

Bill Railey - College of the Mainland, Texas City

Sandra Slider - West Vaco, Derider

Present at the March 10, 1995 meeting:

Bill Hansen - Texas Eastman - Texas Division of Eastman Chemicals, Longview

Richard Coleman - Huntsman Chemical Corp., Pasadena

Dale Anna - Occidental Petrochemical, Dallas

Alex Kajstura - Texas State Technical College

Karen Buchert -Texas State Technical College

The meeting began at 9:30 a.m. with all present members being introduced by Alex Kajstura. Since this was the first time the committee met in this composition, Dr. Kajstura proposed that members take turns describing nature of their operations as well as the way training is done for chemical operators. Bill Hansen was first describing the nature of eastman's operation, followed by a description of their apprenticeship program. Richard Coleman described Huntsman Chemicals, the largest privately owned chemical company in the U.S. , with 7,000 employees and $3.5 billion annual sales. Dale Anna, who is in charge of all Occidental's technical training, described Occidental Chemicals with its over 40 U.S,. plants, very diverse in operations, with operators being trained locally for each of the plants.

The agenda for the day included presentation by Alex Kajstura regarding the progress done on the project. The members of the advisory committee were given a handout containing the preliminary results of the Industry Needs Survey. At the conclusion of this presentation Mr. Anna observed that the results, even though incomplete at this time seem to be confirming his observations from many years of experience with the industry. Mr. Hansen agreed and added that he always felt that TSTC was on the right track working on the Chemical Operations technology program, and that a key to successful

conception and implementation of a new training program is to understand what is going on in the industry; TSTC obviously has this type of staff.

As the next activity, Ms. Buchert distributed the first draft of comprehensive list of competencies that were prepared based on the questions #6 and #7. She explained that this first draft was presented to the committee for evaluation, additions, and deletions. Work on this list followed with Ms. Buchert leading the review of each competency. Some competencies were rephrased to reflect closer terminology used in industry. Upon Mr. Hansen's recommendation, a new competency dealing with compressor instrumentation and control was added to the list under the heading of equipment. Mr. Waite recommended inclusion of competency related to understanding and operating with consideration for safety conditions for personnel, unit and community, under the safety heading. Mr. Anna recommended that for this listing to be meaningful, each of these competencies and skills not only needs to be verified, but also ranked. All the changes were immediately entered into a computer and the committee members received copies of corrected draft.

As the last item on the agenda, Dr. Kajstura presented to the members of the committee information on the THECB guidelines for technical education. He focused in particular on the required number of credit hours, and number of general education courses and credit hours. Mr. Coleman asked about possibility of having the cooperative training listed as one of the courses under the degree plan. because of the uncertainty regarding

college's and/or industries to secure enough coop experience for every student, it was agreed that while very important from students' standpoint, the coop training is better left as approved elective that could be substituted for one of the course in the program.

The meeting was concluded at 12:00 p.m. At that time all members attended a lunch.

Chemical Operation Technology - Curriculum Development

Carl Perkins Grant

Minutes of the Project Advisory Meeting:

Date: May 5, 1995

Advisory Committee Members:

Bill Hansen - Texas Eastman - Texas Division of Eastman Chemicals, Longview

Richard Coleman - Huntsman Chemical Corp., Pasadena

Dale Anna - Occidental Petrochemical, Dallas

David Waite - Atlas Processing Co. - Shreveport

Bruce Clements - Lyondell Petrochemicals, Channelview

Bill Railey - College of the Mainland, Texas City

Sandra Slider - West Vaco, Derider

Present at the May 5, 1995 meeting:

Bill Hansen - Texas Eastman - Texas Division of Eastman Chemicals, Longview

Richard Coleman - Huntsman Chemical Corp., Pasadena

Dale Anna - Occidental Petrochemical, Dallas

Bruce Clements - Lyondell Petrochemicals, Channelview

Alex Kajstura - Texas State Technical College

Karen Buchert -Texas State Technical College

James Booker - TSTC

In the beginning of this last PAC meeting Dr. Kajstura thanked all the present members for all the hard work they put into this project and stated that without these individuals participation the outcomes of this project would not be possible.

As the first item on the agenda, the final results of the Competencies Analysis Survey were presented to the advisory committee by Ms. Buchert. She presented results and commented that very high percentages were recorded of "very strong need" and "strong need" responses, indicating that expected trends and needs of chemical and related industry were very well identified by this particular survey. Mr. Anna commented that he was impressed by the consistency of the responses. Mr. Coleman stated that what he sees collected here is useful not only for the college while working on this project, but also could be immediately useful to many companies in chemical and petrochemical industries.

Next, Dr. Kajstura presented a proposed alignment of all the competencies from the Competencies Analysis Survey into both a six-quarter as well as a four-semester

curricula, to meet different teaching schedules at different two-year colleges in Texas. During the discussion Mr. Hansen brought up the issue of differences in the percentages of the lab time vs. lecture time in the semester system and the quarter system. The consensus was however, that there was sufficient amount of lab time in both time arrangements, assuring that students graduating from both six-quarter as well as four-semester program will have good theoretical preparation and sufficient hands-on experience.

Mr. Waite asked whether it was really critical that our final product has course prefixes and numbers listed, as opposed to course titles alone. After all these can vary from one college to another. Mr. Coleman expressed an opinion that this is better left to a given college's discretion, and mentioned that apparently colleges in Texas are going into common course numbering system. Dr. Kajstura said that this is not happening yet for technical courses. Few other comments brought up by Mr. Coleman and Mr. Waite regarded titles of the courses, but the consensus was that these are about as good and accurate as possible. All of the courses were discussed shortly. Mr. Hansen suggested that a matrix correlating all competencies and course numbers needs to mailed to the members of the committee for a final input before it is included into the final product.

As the last item, Dr. Kajstura asked the members of PAC participating in this last meeting for their possible participation in the future on the Program Advisory Committee for the Chemical Technology Program at TSTC -ETC. Mr. Coleman and Mr. Anna both

expressed their interest and willingness of their companies to release them for such activity.

The meeting was concluded at 11:45 a.m. and followed by the lunch.

CHEMICAL OPERATIONS TECHNOLOGY

APPENDIX B

1. Industrial Needs Survey Results
2. Task Analysis Survey Results

APPENDIX B

1. Industrial Needs Survey Results

TEXAS STATE TECHNICAL COLLEGE
EAST TEXAS CENTER AT MARSHALL
CARL PERKINS CURRICULUM DEVELOPMENT GRANT

CHEMICAL OPERATIONS TECHNOLOGY
INDUSTRY SURVEY AND TASK ANALYSIS

Please circle the most appropriate answer.

1) In general, how do you evaluate the chemical industry need for highly trained chemical operators at this time?

a)	strong	87%
b)	average	13%
c)	none	0%

2) How many chemical operators did your company hire last year?

a)	less than 10	36%
b)	10-20	34%
c)	21-30	11%
d)	31-40	9%
e)	more than 40	10%

3) Based on the current trends, estimate the number of chemical operators that may be hired by your company in the next two years.

a)	less than 10	32%
b)	10-20	17%
c)	21-30	17%
d)	31-40	20%
e)	more than 40	14%

4) What type of training would your company like newly hired chemical operators to have?

a)	on-the-job	14%
b)	apprenticeship	28%
c)	two-year degree in chemical operations technology	58%

5) In recommendations for hiring, would your company prefer to hire a two-year college graduate with the Associate of Applied Sciences degree in chemical operations technology?

a)	yes	85%
b)	no	10%
c)	not a factor	5%

6) How good theoretical understanding and hands-on experience in the following areas should an entry level chemical operator/operations technician have:

	excellent	very good	good	little	not at all
math and algebra	15%	19%	66%		
chemistry fundamentals	70%	30%			
process chemistry	88%	12%			
process solubility	82%	18%			
process reactions	70%	18%	12%		
basic chemical plant operations	86%	10%	4%		
industrial safety	88%	12%			
process sampling	70%	17%	13%		
organic chemistry	60%	27%	13%		
Instrumentation and control: level, temperature, flow, pressure measurements an devices	65%	27%	8%		
Instrumentation and control: analytical measurements	70%	16%	14%		
Instrumentation and control: transmitters, indicators, recorders, alarms, controllers, flow control valves	86%	12%	2%		
process control, dynamics, feed back, feedforward, two-position, proportional, PID	72%	10%	18%		
control loops, PLCs,	72%	10%	18%		
DCS	90%	10%			
reading and using system diagrams	95%	5%			
dimensions and process variable measurements	88%	10%	2%		
principles of force, motion, work, power, efficiency	82%	12%	6%		
basic machines,	80%	18%	2%		
properties of solids, liquids, gases, and flowing fluids	95%	5%			

continued on the next page

cont'd from previous page	excellent	very good	good	little	not at all
heat and heat transfer,	76%	12%	12%		
fluid basics, liquid, gas and vapor systems, process dynamics	79%	12%	9%		
piping and auxiliaries	88%	7%	5%		
electrical and hydraulic systems	88%	7%	5%		
steam turbines, compressors, fans, refrigeration systems, filtration, and screening systems	45%	48%	7%		
boiler systems	43%	48%	9%		
distillation and distillation tower	48%	47%	5%		
azeotropic, extractive, and vacuum columns	31%	38%	31%		
liquid-liquid solvent extractions	31%	36%	33%		
evaporation unit operations	88%	7%	5%		
process reactors	79%	12%	9%		
mixing operations	48%	45%	7%		
furnace operations	45%	48%	7%		
heat exchangers	76%	12%	12%		
Statistics and Statistical Process Control	79%	19%	2%		
material handling equipment	38%	31%	31%		
environmental protection, emergency equipment	88%	7%	5%		

7) Does the graduate need to have:

	excellent	very good	good	little	not at all
good organizational skills	65%	23%	12%		
good communication skills	67%	23%	10%		
creative thinking skills	55%	33%	12%		
problem-solving skills	67%	25%	8%		
ability to work as a team member	88%	12%			
ability to self-motivate	80%	13%	7%		
ability to interact with customers	24%	31%	45%		
ability to present data in writing and oral with visual aids	22%	31%	47%		
ability to "fill in" for other related jobs	36%	25%	49%		

8) Based upon the skills listed above, do you believe that such a graduate would have skills necessary to be hired for an entry-level position as a chemical operator?

a) yes 100%
b) no

9) In your opinion, what will be the industry demand for this type of technician over the next two years?

a)	increase greatly	21%
b)	increase somewhat	57%
c)	remain constant	20%
d)	diminish drastically	0%
e)	no opinion	2%

10) If your company were to hire such a graduate in an entry level position, what would be an approximate salary range? (Provide the range or a typical hourly wage)

$21,000 - 42,000 per year

11) How many employees does your company have?

a)	less than 100	29%
b)	100 - 500	24%
c)	500 - 1000	31%
d)	more than 1000	16%

APPENDIX B

2. Competencies Analysis Survey Results

BASIC THEORY AND SYSTEMS

	Very strong need	strong need	moderate need	nice to know	least need
Math					
Perform addition, subtraction, multiplication, division, operations on fractions and signed numbers, and conversions.	86%	14%			
Calculate percentages, ratios and proportions, powers and roots.	86%	14%			
Understand and perform solving linear equations, systems of equations and algebraic fractions.	30%	22%	32%		16%
Can utilize graphical methods and interpret graphs.	26%	30%	40%		4%
Perform operations with exponents.		12%	40%	48%	
Chemistry					
Understand fundamental concepts of matter, compounds, and mixtures, as well as physical and chemical properties.	42%	58%			
Understand and explain types of chemical reactions and stoichiometry (material and energy balance, limiting factors).	30%	42%	24%		4%
Understand and apply process chemistry concepts such as stoichiometry, reaction rates, catalysts, and chemical equilibrium.	30%	38%	22%		10%
Define, prepare and use various solutions including required calculations.	22%	30%	36%	10%	2%
Define and explain solution-related characteristics such as concentration, rate, crystallization, liquid extraction, absorption, adsorption, and leaching.	22%	30%	36%	10%	2%

Understand fundamental concepts of organic chemistry, including groups of organic compounds, their physical and chemical properties.	25%	70%	5%		
Define, understand, and explain inorganic process reactions such as ionization, redox, neutralization	20%	72%	8%		
Define, understand, and explain organic process reactions such as alkylation, halogenation, and polymerization	25%	70%	5%		
Physical Science					
Understand, describe, and explain scientific principles, laws, and units as applied to process system operation, force, motion, work, heat transfer, mechanics, and fluid dynamics	40%	60%			
Describe and understand the physical properties of solids, liquids, gases	45%	55%			
Explain specific heat, latent heat, heat transfer, and apply these to heat exchangers	42%	54%	4%		
Describe and understand basic principles and effect of pressure and energy in fluid systems.	20%	72%	8%		
Describe measurements of process variables in fluid systems.	45%	51%	4%		
INSTRUMENTATION AND CONTROL					
Define process instrumentation and process variables and demonstrate knowledge of instrument reading techniques.	60%	40%			
Describe design, principles of operation, and applications of common pressure,					

temperature, level, and flow measuring and indicating instruments.	58%	42%			
Define and explain analytical measurement and identify common analytical variables.	32%	52%	10%	6%	
Explain the operation and use of instruments such as pH meter, oxygen meter, hydrometers, colorimeters, turbidity meters, opacity meters, and psychrometers.	26%	42%	30%	2%	
Explain the function and operation of instrument system devices such as transmitters, transducers, recorders, indicators, controllers, and final control elements.	60%	40%			
Identify, define, and explain the purpose, operation, and types of process control systems such as feedback/feedforward control, two-position, proportional, reset, rate, and PID control.	60%	40%			
Describe and explain the control action generated by various process control modes.	56%	44%			
Describe digital control systems, including analog and digital instrument systems, data acquisition, and control loops.	56%	44%			
Explain the functions of programmable controllers, microprocessors, computers, and distributed control systems in process facilities.	42%	52%	6%		
EQUIPMENT					
Describe and explain principles of operation, types, system components, applications, and troubleshooting of heat	62%	38%			

exchangers.					
Describe the operations, design, and chemical treatment of cooling water systems.	44%	50%	6%		
Describe and understand principles of operation, design, troubleshooting, and applications of positive displacement, and centrifugal pumps.	64%	36%			
Have the knowledge of pump auxiliaries, such as drivers, couplings, strainers, lubricating, cooling and sealing system.	60%	40%			
Understand and perform an inspection of an operating pump.	64%	36%			
Have a detailed knowledge of single-stage and multistage centrifugal pumps, parts and functions, and their startup and shutdown procedures.	60%	40%			
Describe principles of operation, design, and applications of reciprocating and rotary pumps, their startup and shutdown procedures.	60%	40%			
Describe and explain purposes, types, and principles of operation of hand and automatic valves.	62%	38%			
Understand and perform specific operator's responsibilities regarding hand and automatic valves and response to their failure.	62%	38%			
Describe and explain principles of operation, components, types and applications of gas compressors and their auxiliaries.	32%	34%	30%	4%	
Have the knowledge of compressor instrumentation and controls, startup and					

shutdown procedures, operational checks, problems and corrective actions, and compressor safety.	32%	34%	30%	4%	
Describe and explain principles of operation, applications, components of steam turbines and their auxiliary devices and systems.	32%	34%	30%	4%	
Understand turbine speed control and protection and operator duties during turbine startup, shutdown, and regular operation.	30%	34%	32%	4%	
Describe, understand, and explain design, types, principles of operation, components, controls, troubleshooting, operations, and safety of induced and forced draft fans.	36%	30%	30%	4%	
SYSTEMS					
Describe basic concepts and use of system diagrams such as flow diagrams and Piping and Instrumentation (P&ID) diagrams.	70%	30%			
Describe the basic operation, components, and power transmission in electrical systems.	40%	42%	18%		
Describe the operation of AC and DC motors, energy conversion, and motor controllers and control circuits.	40%	42%	18%		
Describe, understand, and explain distillation principles, systems, types of towers, and equipment.	70%	30%			
Understand the tower operating conditions and how they affect the process.	70%	30%			
Become proficient in the distillation					

process startup and shutdown procedures, including checks and problems.	60%	30%	10%		
Describe, understand, and explain proper operation of a distillation system, including operating problems.	60%	30%	10%		
Discuss and understand material and energy balances, product composition and process disturbances during distillation.	40%	30%	20%		
Describe, understand, and explain distillation principles, systems of azeotropic, extractive, and vacuum columns.	40%	30%	20%		
Explain the principles of operation (heat transfer, air, fuel,water and steam flow), and types of boilers.	32%	30%	20%	18%	
Discuss and understand boiler's control systems and instrumentation, fuel systems and condensate and feedwater systems.	32%	30%	20%	18%	
Understand procedures and operator's responsibilities during routine operations, boiler startup and shutdown, as well as boiler-related safety.	32%	30%	20%	18%	
Describe, understand, and explain design, principles of operation, components and troubleshooting of various types of reactors (stirred tank, tubular, and catalytic bed).	32%	30%	38%		
Understand procedures and be able to perform operator's duties during reactor operation, startup and cooldown.	32%	30%	38%		
Describe, understand, and explain design, principles of operation,					

components and troubleshooting of evaporator systems, their operation, startup and shutdown.	22%	30%	42%	6%	
Explain the principles of operation of refrigeration systems, including factors affecting operation.	22%	30%	42%	6%	
Understand refrigeration system controls and applications.	22%	30%	42%	6%	
Describe, understand, and explain principles of hydraulic system and applications such as pressure control valves, directional control valves, flow control, and hydraulic actuators and motors, including operator's responsibilities regarding these systems.	64%	36%			
Describe, understand, and explain design, principles of operation, types, components and troubleshooting of mixers, including operator's responsibilities and mixer-related safety.	42%	44%	14%		
Describe, understand, and explain design, principles of operation of various types of extraction systems.	32%	34%	30%	6%	
Explain the principles of operation (heat transfer, air, fuel flow), types of furnaces, their instrumentation and control, startup, routine operation, shutdown, troubleshooting, and operator responsibilities..	38%	28%	18%	18%	
Describe, understand, and explain the role of filtering and screening, types of filters and screens, their operations and operator responsibilities.	42%	44%	14%		
Understand and explain water and wastewater chemical and mechanical treatment, including operator	38%	28%	18%	18%	

responsibilities and safety.					
Understand and apply proper lubrication, including seals, packing, oils, greases, solid lubricants.	32%	30%	38%		
SAFETY					
Understand the concept of process safety management program and its elements, including employee involvement and process safety information.	42%	44%	14%		
Understand and implement typical standards and regulations for chemical and related industries including PSM, EPA regulations, Clean Air Act, fugitive emissions regulations, HazCom, HazWoper, ISO 9000 and SARA regulations.	26%	30%	40%	4%	
Understands and can operate with consideration for safety conditions for personnel, unit and community.	42%	44%	14%		
Understands and can follow permit, lockout/tagout, and confined space procedures, and perform startups, and shutdowns.	32%	44%	24%		
Understands principles of operation and can use emergency equipment such as gas analyzers, respirators, and fire protection equipment.	32%	44%	24%		
Can use personal protective gear, safety tools and equipment.	32%	44%	24%		
Understands safety issues in fire prevention and material handling.	32%	44%	24%		
Understand chemical dependency issues as related to job performance.	70%	30%			

SPC

Understand and utilize basic statistical concepts.	30%	46%	24%		
Understand and describe quality improvement techniques	30%	46%	24%		
Collect and interpret written and oral data, perform scheduled readings, and complete product sample and lab analysis reports and unit logs.	42%	56%	2%		
Utilize and apply control charts for variables, SPC techniques for variables including continuous and batch processes and short run SPC.	30%	36%	34%		
Understand and discuss fundamental concepts of variation and probability	30%	46%	24%		
Apply and utilize control charts for attributes	30%	36%	34%		
Use lot-by-lot acceptance sampling by attributes	32%	34%	34%		
Apply acceptance sampling plan systems	20%	36%	34%	10%	
Understand and utilize concept of reliability	20%	36%	34%	10%	
Understand and analyze quality costs	20%	26%	34%	20%	
Be aware of computer applications in quality control	30%	36%	34%		
Become familiar with the concept and practical applications of Total Quality Management	32%	34%	34%		

INTERPERSONAL SKILLS

Develop good organizational,

communication, creative thinking, and problem-solving skills.	42%	54%	4%		
Acquire the ability to work as a team member, interact with internal and external customers, and to be self-motivated.	42%	54%	4%		
Develop ability to prepare written reports and give oral presentations using visual aides when needed.	28%	30%	32%	10%	
Is able to coordinate and communicate his/her actions with others	36%	54%	10%		
Understands the issues of quality management.	26%	30%	32%	12%	

APPENDIX C

List of Companies Surveyed

Amoco Chemical Co.
Chocolate Bayou Plant
Box 1488
Alvin, TX 77511

Amoco Production Co
P.O. Box 12550
Odessa, TX 79758-2250

Aristech Chemical Corp
PO Box 1436
La Porte, TX 77572

Ashland Petroleum Co
PO Box 391
Ashland, KY 41114

Bay City Plastics Corp.
Box 1683
Bay City, TX 77414

B D Payne & Assoc Inc
Suite 161
Stafford, TX 77477

BASF Corp.
Freeport Plant
602 Copper Rd.
Freeport, TX 77541

BASF Corp
PO Box 457
Geisman, LA 70734

BASF Corp
1609 Biddle Ave
Wyandotte, WI 48192

BASF Corp
State Rt 571 E
Greenville, OH 45331

BP Chemicals
PO Box 659

Port Lavaca, TX 77979

BP Oil Co, Toledo Refinery
PO Box 696
Toledo, OH 43697-0696

Burroughs Wellcome
PO Box 1887
Greenville, NC 27834

Callery Chemical Co
PO Box 429
Pittsburgh, PA 15230

Cape Industries
PO Box 327
Wilmington NC 28402

Champlin refining Co.
Box 9176
Corpus Christi, TX 78469

Chevron Chemical Co
PO Box 70
Belle Chasse, LA 70037

Chevron Chemical Co
PO Box 509
Baytown, TX 77522

Chevron Chemical Co.
1515 Sheldon Rd.
Channelview, TX 77530

Chevron USA Inc
Pascagoula Refinery
PO Box 1300
Pascagoula, MS 39588-1300

Chevron USA Inc
2351 N 1100 W
Salt Lake City, UT 84125

Ciba-Geigy Corp

PO Box 113
McIntosh, AL 36553

Ciba-Geigy Corp
PO Box 11
St Gabriel, LA 70776

Ciba-Geigy Corp
556 Morris Ave
Summit, NJ 07901

Hartford Refinery
PO Box 7
Hartford, IL 62048

Coastal Refining Co
1300 Cantwell Ln
Corpus Christi, TX 78403

Custom Resins
PO Box 933
Henderson, KY 42420

Diamond Shamrock
9830 Colonnade
San Antonio, TX 78230

Dow Chemical USA
Drawer K
Freeport, TX 77541

Dow Chemical Co
PO Box 150
Plaquemine, LA 60665-0150

Dow Chemical USA
Michigan Division
Midland, MI 48647

Dow Corning Corp
760 Hodgenville Rd
Elizabethtown, KY 42701

E I Dupont de Nemours & Co

Chambers Works
Monstral Bldg
Rt 130
Deepwater, NJ 08023

E I Dupont de Nemouirs & Co
901 W Dupont Ave
Belle, WV 25015

E I Dupont de Nemours & CO
Sabine River Works
PO Box 1089
Orange, TX 77630

E I Dupont de Nemours & Co
12502 Strange Rd
PO Box 347
La Porte, Tx 77572-0347

E I Dupont de Nemours & Co
PO Box 2000
La Place, LA 70069-1150

E I Dupont de Nemours & Co
PO Box 27038
2572 Fite Rd
Memphis, TN 38127

Eastman Chemical Co
Tennessee Eastman Division
PO Box 511
Kingsport, TN 37662

Eastman Chemical Co
Arkansas Eastman Division
PO Box 2357
Batesville, AR 72503

Eastman Chemical Co
Kodak Park
Rochester, NY 14652-3623

Elf Atochem North America
2316 Highland Ave

Carrollton, KY 41008

Eli Lilly & Co
PO Box 685
Lilly Rd
Lafayette, IN 47902

Eli Lilly & Co
Lilly Corporate Center
Indianapolis, IN 46285

Exxon Chemical Co USA
PO Box 23
Linden, NJ 07036

Exxon Chemical USA
301 Old Choate Rd
Houston, TX 77034

Exxon Chemical Americas
5000 Bayway Dr.
Baytown, TX 77520

Fina Inc.
Box 1311
Big Spring,TX 79721

Mobay Corp.
8500 W. Bay Rd
Baytown, TX 77520
North & Linden
PO Box 570
Coffeyville, KS 67337

GE Plastics Co
PO Box 658
Ottawa, IL 61350

General Electric Plastics Division
1 Lexan Lane
Mt Vernon, IN 47620

Georgia Gulf Corp
PO Box 629

Plaquemine, LA 70765

Glidden Co
925 Euclid Ave
Cleveland, OH 44115

Great Lakes Chemical Corp
PO Box 1878
El Dorado, AR 71730

Goodyear Tire and Rubber Co
Box 26003
Beaumont, TX 77720

GTE Products Corp
Hawes St
Towanda, PA 18848

Hoechst Celanese Group
500 Washington St
Coventry, RI 02816

Hoechst Celanese Engineering
Box 428
Bishop, TX 78343

Huls America Inc
Turner Pl
Piscataway, NJ 08854

Huls America Inc
PO Box 889
Theodore, AL 36590

Huntway Refining Co
PO Box 187
Benicia, CA 94510

Huntway Refining
5415 E Randolph Rd
Coolidge, AZ 85228

Huntway Refining Co
PO Box 1257

Wilmington, CA 90748

ICI Americas Inc
229 E 22nd St
Bayonne, NJ 07002

ICI Americas Inc
5757 Underwood Rd
Pasadena, Tx 77507

IMC Fertilizer Inc
PO Box 1035
Mulberry, Fl 33860

IMC Fertilizer Inc
PO Box 626
Sterlington, LA 71280

Kerr-McGee Chemical Corp
PO Box 180
Hamilton, MS 39746

Jones-Blair Co.
2728 Empire Central
Dallas, TX 75235

Koch Refining Co.
Box 2608
Corpus Christi, TX 78403

Kronos Inc
PO Box 70
Westlake, LA 70669-0070

Lyondell Petrochemical
Box 777
Chamnnelview, TX 77530

Lyondell Petrochemical Co
PO Box 2451
Houston, TX 77252-2451

Mapco Petroleum Inc
PO Box 2930

543 W Mallory
Memphis, TN 38101

Marathon Oil Co.
Box 1191
Texas City, TX 77592

Melamine Chemicals Inc
PO Box 748
Donaldsonville, LA 70346

Merck & Co
PO Box 7
Elkton, VA 22827

Miles Inc
8500 W Bay Rd
Baytown, TX 77520

Miles Inc
PO Box 2000
Orange, TX 77521

Mobil Chemical Corp
Polymer Chemicals
PO Box 550
Joliet, IL 60434-0550

Mobil Chemical Corp
PO Box 250
Route 27 & Vinegard Rd
Edison, NJ 08818

Mobil Oil Co
PO Box 3311
Beaumont, TX 77704

Mobil Oil Corp
Paulsboro Refinery
800 Billingsport Rd
Paulsboro, NJ 08066

Mobil Oil Corp
3225 Gallows Rd

PO 3601
Fairfax, VA 22037-0001

Mobil Oil Corp
PO Box 3311
Beaumont, TX 77704

Monsanto Chemical Co
RR 5
PO Box 473
Muscatine, IA 52781

Monsanto Chemical Co
PO Box 2307
Fayetteville, NC 28301

Monsanto Chemical Co
John F Queeney Plant
1700 S 2nd ST
St Louis, Mo 63177-7040

Monsanto Chemical Co
PO Box 174
Luling, LA 70070

Nalco Chemical Co
PO Box 87
Sugar Land, TX 77487

Occidental Chemical Co
5005 L B J Freeway
Dallas, TX 75244

Occidental Chemical Co
7377 Hwy 3214
Convent, LA 70723

Occidental Chemical Co
PO Box 344
Niagara Falls, NY 14302

Olin Chemical Corp
2450 Olin Rd
Brandenburg, KY 40108-0547

Olin Chemical Corp
PO Box 2896
Lake Charles, LA 70602

Olin Chemical Corp
Lower Ri ver Rd
Charleston, TN 37310

Olin Chemical Corp
PO Box 28
McIntosh, AL 36553

Oxy-Chem Petrochemicals
Box 2917
Alvin, TX 77512

Pfizer Specialty Chemicals
Eastern Point Rd
Groton, CT 06340

Phibro Energy Corp
PO Box 453
Krotz Springs, LA 70750

Phillips 66
Box 866
Sweeny, TX 77480

PMC
2700 S. Westmoreland
Dallas, TX 75376

Pride Refining Inc.
Box 3237
Abilene, TX 79604

Quantum Chemical Co
PO Box 218
Tuscola, IL 61953

Quantum Chemical Co
USI Division
8805 N Tabler Rd
Morris, IL 60450

Quantum Chemical Co
PO Box 2919
Clinton, IA 52732-2919

Quantum Chemical Corp.
1515 Miller Cut-off rd.
Deer Park, TX 77536

Rhone-Poulenc Inc
500 Arcola Rd
Collegeville, PA 19426

Rhone-Poulenc Inc
PO Box 2831
Charleston, WV 25330

Rohm & Haas
PO Box 672
Deer Park, TX 77536

Rohm & Haaas
PO Box 219
Bristol, PA 19007

Schering-Plough
1011 Morris Ave
Union, NJ 07083

SCM Chemicals Inc
3901 Ft Armistead Rd
Baltimore, Md 21226-1899

Searle Pharmaceutical Co
1750 Lovers Ln
Augusta, Ga 30901

Shell Chemical Co
PO Box 160
Hahnville, LA 70057

Shell Oil Co
13700 A Dolphin Island Pkwy
Coden, AL 38523

Shell Oil Co
Deer Park Mfg Complex
Deer Park, TX 77536

Shell Western
300 Shell Oil Rd
Brandon, MS 39042

Solvay Polymers Inc.
1230 Battleground Rd.
Deer Park, TX 77536

Star Enterprise
Box 712
Port Arthur, TX 77641

Sun Oil Co
1700 S Union St
Tulsa, OK 74102

Sun Refining & Marketing
PO Box 2039
Tulsa, OK 74102

Sunbelt Refining Co
PO Box 2179
Coolidge, AZ 85044

Syntex Agribusiness
PO Box 1246
Springfield, MO 65801

Texas Petrochemicals
8600 Park Place Blvd.
Houston, TX 77017

U O P Inc
PO Box 21566
Shreveport, LA 71120

Union Carbide Corp
PO Box 186
Port Lavaca, TX 77979

Uniroyal Chemical Co
PO Box 397
Geismar, LA 70734

Unocal Inc
L.A. Refinery
1660 W Anaheim St
Wilmington, CA 90744

W R Grace & Co
Organic Chemicals Division
2 E Spit Brook Rd
Nashua, NJ 03061

Warren Petroleum Co
PO Box 1589
Tulsa, OK 74102

Warren Petroleum Co
1901 Florissant Hwy
St Bernard, LA 70085

Warren Petroleum Co
PO Box 1110
Mt Belvieu, TX 77580

Warren Petroleum Co
PO Box 60210
Midland, TX

Westlake Polymers Co
PO Box 3089
Lake Charles, LA 70702

Witco Chemical Co
PO Box 310
Hahnville, LA 70057

Wyckoff Chemical Co Inc
1421 Kalamazoo St
South Haven, MI 49090

CHEMICAL OPERATIONS TECHNOLOGY

APPENDIX D

1. Curriculum in a Quarter Format
2. Course Descriptions for Quarter Format
3. Curriculum in a Semester Format
4. Course Descriptions for Semester Format
5. Competencies and Courses Matrix

APPENDIX D

1. Curriculum in a Quarter Format

CHEMICAL OPERATIONS TECHNOLOGY CURRICULUM
(QUARTERS)

FIRST QUARTER		LEC	LAB	CR
CHT 120	General Chemistry I	4	6	6
CHT 122	Chemical Calculations I	3	3	4
ENGL 1301	Composition I	4	0	3
MATH 1314	College Algebra	4	0	3
		13	12	16
SECOND QUARTER				
CHT 124	General Chemistry II	4	6	6
CHT 204	Chemical Calculations II	3	3	4
CHT 116	Intro. to Chem. Industry and Operations	3	3	4
MATH 1316	Plane Trigonometry	4	0	3
		14	12	17
THIRD QUARTER				
ENGL 134	Interpersonal Communications	4	0	3
	General Educ. PSYC or SOC	4	0	3
MTH 202	Basic Statistics and SPC	3	3	4
PHYS 1401	College Physics	4	4	4
		15	7	14
FOURTH QUARTER				
PSYC 1316	Critical Thinking and Problem Solving	4	0	3
CNS 2060	Applications Software	1	4	3
CHT 230	Chemical Industry Stds. and Regs.	3	3	4
CHT 260	Instrumentation and Control I	3	3	4
		13	10	14
FIFTH QUARTER				
CHT 270	Instrumentation and Control II	3	3	4
CHT 320	Process Equipment Operations I	3	3	4
CHT 350	Plant Operations and Systems I	3	3	4
OSH 112	Process Operations Safety	3	3	4
		15	12	16

SIXTH QUARTER

CHT 280	Instrumentation and Control III	3	3	4
CHT 330	Process Equipment Operations II	3	3	4
CHT 360	Plant Operations and Systems II	3	3	4
OSH 212	Environmental Health	2	3	3
	Free Elective	4	0	3
		15	12	18
	TOTAL	84	71	100

APPENDIX D

2. Course Descriptions for Quarter Format

CHT 116 Introduction to Chemical Industry and Operations (3-3-4).

A study of the development and industrial prominence of the chemical industry in Texas and United States. Opportunities for technician in the industry are spotlighted. Industrial films and visits are used extensively to illustrate the scope of chemical production. Most typical chemical processes in industry are presented.

CHT 120 General Chemistry I (4-6-6).

Basic principles are introduced. Emphasis is placed on fundamental laws, atomic structure, bonding, acids and bases, periodic classification of elements and solutions.

CHT 124 General Chemistry II (4-6-6).

Continuation of CHT 120. Covers molecular structures, thermodynamics, kinetics, chemical equlibria, nuclear chemistry and electrochemistry.
Prerequisite:CHT 120.

CHT 230 Chemical Industry Standards and Regulations (3-3-4).

Presentation and interpretation of typical standards and regulations for chemical and related industries including Plant Safety Management (PSM), EPA regulations, Clean Air Act, Fugitive Emissions regulations, HazCom, HazWoper, ISO 9000, and SARA regulations.

CHT 260 Instrumentation and Control I (3-3-4).

The purpose of this course is to provide introduction to instrumentation and control as it applies to process system measurement. Commonly measured process variables are identified and techniques of their measurement are discussed. Description of the

operating principles used to measure and indicate pressure, temperature, level and flow are provided.

CHT 270 Instrumentation and Control II (3-3-4).

This more advanced course introduces instrument systems and their application to measure and control process variables. Basic process control methods such as feedback and feedforward, as well as process dynamics are presented. Students also learn to read, interpret, and use P&ID, flow, and electrical diagrams.
Prerequisite:CHT 260

CHT 280 Instrumentation and Control III (3-3-4).

This most advanced instrumentation and control course describes and explains process control systems and several types of control mode operations, including two-position, proportional, and PID control. Control loops, PLCs, information displays are introduced as components od digital control systems. The course discusses also Distributed Control Systems including discrete, continuous, batch and numerical control systems.
Prerequisite:CHT 270

CHT 320 Process Equipment Operations I (3-3-4).

This course introduces students to the major types of equipment used in industrial facility. Equipment such as various valves, piping, protective devices, and their operations are discussed. Operations of industrial steam traps, heat exchangers, cooling towers, condensers, reboilers are discussed. Electrical distribution, hydraulic, and emergency systems are introduced and their components are presented.

CHT 330 Process Equipment Operations II (3-3-4).

A continuation of CHT 320, this course allows students to become familiar with the purpose and use of other equipment commonly used in various industries such as screens and filters, couplings, drives, pumps, steam turbines, compressors, and refrigeration systems. Students learn the principles of operation and factors affecting operation.

Prerequisite:CHT 320

CHT 350 Plant Operations and Systems I (3-3-4).

A study of operations of various systems and processes found in chemical and related plants, such as distillation, distillation tower, azeotropic, extractive, and vacuum columns operations, liquid-liquid solid extraction, evaporation units operations. Introduction to gas chromatography is included.

CHT 360 Plant Operations and Systems II (3-3-4).

This course is a continuation of CHT 350 and includes study of other systems and devices being system components such as reactors, mixers, boilers, fans, furnaces, and water treatment systems.
Prerequisite:CHT 350

MTH 202 Basic Statistics and Statistical Process Control (3-3-4).

This course covers basic statistical concepts such as probability, sampling, correlation, variation, analysis of variance. This course also introduces student to SPC and its applications to the process. SPC concepts such as control charts, out-of-control processes, patterns of instability, trend indications, warning line and control limit violations, cycling and overcontrol, and CUSUM are introduced.
Prerequisite:Math 1314

OSH 112 Process Operations Safety (2-3-3).

A course to cover basic principles used to establish safe control measures for work with industrial chemicals. Process Safety Management program and its elements are discussed. Permit, lockout/tagout, and confined space procedures are explained. Use of personal protective gear, safety tools, and fire prevention is presented.
Prerequisite: CHT 102 or CHT 120

OSH 212 Environmental Health (2-3-3).

An introductory study dealing with the recognition and evaluation of hazards in the workplace environment. Air contamination detection instruments will be studied as well.

ENGL 1301 Composition I (4-0-3).

Students study the process of composing essays, including prewriting techniques, drafting, and revising and editing. Students write several multi-paragraph essays of different types, in both in-class and out-of-class settings. students critically analyze sample student and professional essays.

ENGL 134 Interpersonal Communication (4-0-3).

Theories and exercises in verbal and nonverbal communication with focus on interpersonal relationships. Students will study internal and external factors that impact communication, communication clarification, and conflict resolution.
Prerequisite: ENGL 1301

MATH 1314 College Algebra (4-0-3).

A study of quadratics, polynomial, rational, logarithmic and exponential functions, systems of equations, progressions, sequences and series, matrices and determinants.

MATH 1316 Trigonometry (4-0-3).

Topics in trigonometric functions, right triangles, trigonometric identities, radian measure, graphs of periodic functions, and oblique triangles.
Prerequisite: MATH 1314.

PHYS 1401 College Physics (4-4-4).

This course is for students who need a technical course ion physics. This course includes mechanics, dynamics, heat, and sound. Emphasis is on fundamental concepts, their applications and problem solving.

CNS 2060 Applications Software (1-4-3).

A course includes introductory concepts combined with an emphasis on more predominate computer software including but not limited to DOS, wordprocessing, spreadsheets, and databases providing students with computer literacy and ability to meet basic computer requirements at work.

APPENDIX D

3. Curriculum in a Semester Format

CHEMICAL OPERATIONS TECHNOLOGY CURRICULUM
(SEMESTERS)

		LEC	LAB	CR
FIRST SEMESTER				
CHEM 1411	General Chemistry I	3	3	4
ENGL 1301	Composition I	3	0	3
	General Educ. PSYC or SOC	3	0	3
COSC 1301	Computer Applications	2	2	3
MATH 1314	College Algebra	3	0	3
		14	5	16
SECOND SEMESTER				
CHEM 1412	General Chemistry II	3	3	4
ENGL 2303	Interpersonal Communications	3	0	3
CHEM 1316	Intro. to Chem. Industry and Operations	2	2	3
PSYC 1316	Critical Thinking and Problem Solving	3	0	3
MATH 1316	Plane Trigonometry	3	0	3
		14	5	16
THIRD SEMESTER				
MATH 1402	Basic Statistics and SPC	2	2	3
	Free Elective	3	0	3
CHT 230	Chemical Industry Stds. and Regs.	2	2	3
INT 2401	Instrumentation and Control I	3	3	4
PHYS 1401	College Physics	3	3	4
		13	10	17
FOURTH SEMESTER				
OSH 212	Environmental Health	2	2	3
INT 2402	Instrumentation and Control II	3	3	4
CHT 320	Process Equipment Operations	3	3	4
CHT 350	Plant Operations and Systems	3	3	4
OSH 112	Process Operations Safety	2	2	3
		15	12	18
	TOTAL	56	32	67

APPENDIX D

Course Descriptions in the Semester Format

CHT 1316 Introduction to Chemical Industry and Operations (3-0-3).

A study of the development and industrial prominence of the chemical industry in Texas and United States. Opportunities for technician in the industry are spotlighted. Industrial films and visits are used extensively to illustrate the scope of chemical production. Most typical chemical processes in industry are presented.

CHEM 1411 General Chemistry I (3-3-4).

Basic principles are introduced. Emphasis is placed on fundamental laws, atomic structure, bonding, acids and bases, periodic classification of elements and solutions.

CHEM 1412 General Chemistry II (3-3-4).

Continuation of CHEM 1401. Covers molecular structures, thermodynamics, kinetics, chemical equlibria, nuclear chemistry and electrochemistry.
Prerequisite:CHEM 1411.

CHT 230 Chemical Industry Standards and Regulations (2-2-3).

Presentation and interpretation of typical standards and regulations for chemical and related industries including Plant Safety Management (PSM), EPA regulations, Clean Air Act, Fugitive Emissions regulations, HazCom, HazWoper, ISO 9000, and SARA regulations.

INT 2401 Instrumentation and Control I (3-3-4).

The purpose of this course is to provide introduction to instrumentation and control as it applies to process system measurement. Commonly measured process variables are identified and techniques of their measurement are discussed. Description of the

operating principles used to measure and indicate pressure, temperature, level and flow are provided. Students also learn to read, interpret, and use P&ID, flow, and electrical diagrams.

INT 2402 Instrumentation and Control II (3-3-4).

This more advanced course introduces instrument systems and their application to measure and control process variables. Basic process control methods such as feedback and feedforward, as well as process dynamics are presented. The course describes and explains process control systems and several types of control mode operations, including two-position, proportional, and PID control. Control loops, PLCs, information displays are introduced as components od digital control systems. The course discusses also Distributed Control Systems including discrete, continuous, batch and numerical control systems.

Prerequisite: INT 2401.

CHT 320 Process Equipment Operations (3-3-4).

This course introduces students to the major types of equipment used in industrial facility. Equipment such as various valves, piping, protective devices, and their operations are discussed. Operations of industrial steam traps, heat exchangers, cooling towers, condensers, reboilers are discussed. Electrical distribution, hydraulic, and emergency systems are introduced and their components are presented. Students become familiar with the purpose and use of other equipment commonly used in various industries such as screens and filters, couplings, drives, pumps, steam turbines, compressors, and refrigeration systems. Students learn the principles of operation and factors affecting operation.

CHT 350 Plant Operations and Systems *(3-3-4)*

A study of operations of various systems and processes found in chemical and related plants, such as distillation, distillation tower, azeotropic, extractive, and vacuum columns operations, liquid-liquid solid extraction, evaporation units operations. Introduction to other systems and devices being system components such as reactors, mixers, boilers, fans, furnaces, and water treatment systems.

MTH 202 Basic Statistics and Statistical Process Control (3-3-4).

This course covers basic statistical concepts such as probability, sampling, correlation, variation, analysis of variance. This course also introduces student to SPC and its applications to the process. SPC concepts such as control charts, out-of-control processes, patterns of instability, trend indications, warning line and control limit violations, cycling and overcontrol, and CUSUM are introduced.
Prerequisite:Math 1314

OSH 112 Process Operations Safety (2-2-3).

A course to cover basic principles used to establish safe control measures for work with industrial chemicals. Process Safety Management program and its elements are discussed. Permit, lockout/tagout, and confined space procedures are explained. Use of personal protective gear, safety tools, and fire prevention is presented.
Prerequisite: CHT 102 or CHT 120.

OSH 212 Environmental Health (2-2-3).

An introductory study dealing with the recognition and evaluation of hazards in the workplace environment. Air contamination detection instruments will be studied as well.

ENGL 1301 Composition I (3-0-3).

Students study the process of composing essays, including prewriting techniques, drafting, and revising and editing. Students write several multi-paragraph essays of different types, in both in-class and out-of-class settings. students critically analyze sample student and professional essays.

ENGL 134 Interpersonal Communication (3-0-3).

Theories and exercises in verbal and nonverbal communication with focus on interpersonal relationships. Students will study internal and external factors that impact communication, communication clarification, and conflict resolution.
Prerequisite: ENGL 1301

MATH 1314 College Algebra (3-0-3).

A study of quadratics, polynomial, rational, logarithmic and exponential functions, systems of equations, progressions, sequences and series, matrices and determinants.

MATH 1316 Trigonometry (3-0-3).

Topics in trigonometric functions, right triangles, trigonometric identities, radian measure, graphs of periodic functions, and oblique triangles.
Prerequisite: MATH 1314.

PHYS 1401 College Physics (3-3-4).
This course is for students who need a technical course ion physics. This course includes mechanics, dynamics, heat, and sound. Emphasis is on fundamental concepts, their applications and problem solving.

COSC 1301 Computer Applications (2-2-3).

A course includes introductory concepts combined with an emphasis on more predominate computer software including but not limited to DOS, wordprocessing, spreadsheets, and databases providing students with computer literacy and ability to meet basic computer requirements at work.

SIX-QUARTER CURRICULUM MATRIX

	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Perform addition, subtraction, multiplication, division, operations on fractions and signed numbers, and conversions.	●	●		●	●	●				●	●
Calculate percentages, ratios and proportions, powers and roots.	●	●		●	●	●				●	●
Understand and perform solving linear equations, systems of equations and algebraic fractions.	●	●		●	●	●				●	●
Can utilize graphical methods and interpret graphs.	●	●		●	●	●				●	●
Perform operations with exponents.	●	●		●	●	●				●	●
Understand fundamental concepts of matter, compounds, and mixtures, as well as physical and chemical properties.	●	●			●	●	●				
Understand and explain types of chemical reactions and stoichiometry (material and energy balance, limiting factors).	●	●			●	●					
Understand and apply process chemistry concepts such as stoichiometry, reaction rates, catalysts, and chemical equilibrium.	●	●			●	●					
Define, prepare and use various solutions including required calculations.	●	●			●	●					
Understand fundamental concepts of organic chemistry, including groups of organic compounds, their physical and chemical properties.	●	●			●	●	●				

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	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Define, prepare and use various solutions including required calculations.	●	●			●	●					
Define and explain solution-related characteristics such as concentration, rate, crystallization, liquid extraction, absorption, adsorption, and leaching.											
Understand fundamental concepts of organic chemistry, including groups of organic compounds, their physical and chemical properties.											
Define, understand, and explain inorganic process reactions such as ionization, redox, neutralization	●				●						
Define, understand, and explain organic process reactions such as alkylation, halogenation, and polymerization					●						
Understand, describe, and explain scientific principles, laws, and units as applied to process system operation, force, motion, work, heat transfer, mechanics, and fluid dynamics	●	●			●	●					●
Describe and understand the physical properties of solids, liquids, gases	●	●			●	●					●
Explain specific heat, latent heat, heat transfer, and apply these to heat exchangers	●	●			●	●					●
Describe and understand basic principles and effect of pressure and energy in fluid systems.											●

	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Understand and implement typical standards and regulations for chemical and related industries including PSM, EPA regulations, Clean Air Act, fugitive emissions regulations, HazCom, HazWoper, ISO 9000 and SARA regulations.											
Understands and can operate with consideration for safety conditions for personnel, unit and community.											
Understands and can follow permit, lockout/tagout, and confined space procedures, and perform startups, and shutdowns.											
Understands principles of operation and can use emergency equipment such as gas analyzers, respirators, and fire protection equipment.											
Can use personal protective gear, safety tools and equipment.											
Understands safety issues in fire prevention and material handling.											
Understand chemical dependency issues as related to job performance.											
Understand and utilize basic statistical concepts.										●	
Understand and describe quality improvement techniques.										●	

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	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Collect and interpret written and oral data, perform scheduled readings, and complete product sample and lab analysis reports and unit logs.										●	
Utilize and apply control charts for variables, SPC techniques for variables including continuous and batch processes and short run SPC.										●	
Understand and discuss fundamental concepts of variation and probability										●	
Apply and utilize control charts for attributes										●	
Use lot-by-lot acceptance sampling by attributes										●	
Apply acceptance sampling plan systems										●	
Understand and utilize concept of reliability										●	
Understand and analyze quality costs										●	
Be aware of computer applications in quality control										●	
Become familiar with the concept and practical applications of Total Quality Management										●	
Develop good organizational, communication, creative thinking, and problem-solving skills.	●				●				●	●	
Acquire the ability to work as a team member, interact with internal and external customers, and to be self-motivated	●				●				●		●

	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Develop ability to prepare written reports and give oral presentations using visual aides when needed.	●				●		●		●	●	
Is able to coordinate and communicate his/her actions with others	●				●						
Understands the issues of quality management										●	

SIX-QUARTER CURRICULUM MATRIX

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Perform addition, subtraction, multiplication, division, operations on fractions and signed numbers, and conversions				●	●				●			
Calculate percentages, ratios and proportions, powers and roots				●	●				●			
Understand and perform solving linear equations, systems of equations and algebraic fractions				●	●				●			
Can utilize graphical methods and interpret graphs				●	●				●			
Perform operations with exponents				●	●				●			
Understand fundamental concepts of matter, compounds, and mixtures, as well as physical and chemical properties												
Understand and explain types of chemical reactions and stoichiometry (material and energy balance, limiting factors)												
Understand and apply process chemistry concepts such as stoichiometry, reaction rates, catalysts, and chemical equilibrium												
Define, prepare and use various solutions including required calculations												
Understand fundamental concepts of organic chemistry, including groups of organic compounds, their physical and chemical properties												

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Define process instrumentation and process variables and demonstrate knowledge of instrument reading techniques.				●	●				●			
Describe design, principles of operation, and applications of common pressure, emperature, level, and flow measuring and indicating instruments.				●	●				●			
Define and explain analytical measurement and identify common analytical variables.				●	●				●			
Explain the operation and use of instruments such as pH meter, oxygen meter, hydrometers, colorimeters, turbidity meters, opacity meters, and psychrometers.				●	●				●			
Explain the function and operation of instrument system devices such as transmitters, transducers, recorders, indicators, controllers, and final control elements.				●	●				●			
Identify, define, and explain the purpose, operation, and types of process control systems such as feedback/feedforward control, two-position, proportional, reset, rate, and PID control.				●	●				●			
Describe and explain the control action generated by various process control modes.				●	●				●			
Describe digital control systems, including analog and digital instrument systems, data acquisition, and control loops.				●	●				●			

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	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Explain the functions of programmable controllers, microprocessors, computers, and distributed control systems in process facilities.					●				●			
Describe and explain principles of operation, types, system components, applications, and troubleshooting of heat exchangers.						●	●			●	●	
Describe the operations, design, and chemical treatment of cooling water systems.						●	●			●	●	
Describe and understand principles of operation, design, troubleshooting, and applications of positive displacement, and centrifugal pumps.						●	●			●	●	
Have the knowledge of pump auxiliaries, such as drivers, couplings, strainers, lubricating, cooling and sealing system.						●	●			●	●	
Understand and perform an inspection of an operating pump.						●	●			●	●	
Have a detailed knowledge of single-stage and multistage centrifugal pumps, parts and functions, and their startup and shutdown procedures.						●	●			●	●	
Describe principles of operation, design, and applications of reciprocating and rotary pumps, their startup and shutdown procedures.						●	●			●	●	
Describe and explain purposes, types, and principles of operation of hand and automatic valves.						●	●			●	●	

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Understand and perform specific operator's responsibilities regarding hand and automatic valves and response to their failure.						●	●			●	●	
Describe and explain principles of operation, components, types and applications of gas compressors and their auxiliaries.						●	●			●	●	
Have the knowledge of compressor instrumentation and controls, startup and shutdown procedures, operational checks, problems and corrective actions, and compressor safety.						●	●			●	●	
Describe and explain principles of operation, applications, components of steam turbines and their auxiliary devices and systems.						●	●			●	●	
Describe and explain principles of operation, applications, components of steam turbines and their auxiliary devices and systems.						●	●			●	●	
Describe, understand, and explain design, types, principles of operation, components, controls, troubleshooting, operations, and safety of induced and forced draft fans.						●	●			●	●	
Describe basic concepts and use of system diagrams such as flow diagrams and Piping and Instrumentation (P&ID) diagrams.										●	●	
Describe the basic operation, components, and power transmission in electrical systems.				●	●				●	●		

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Describe the operation of AC and DC motors, energy conversion, and motor controllers and control circuits.						●	●			●	●	
Describe, understand, and explain distillation principles, systems, types of towers, and equipment.						●	●			●	●	
Understand the tower operating conditions and how they affect the process.							●			●	●	
Become proficient in the distillation process startup and shutdown procedures, including checks and problems.							●			●	●	
Describe, understand, and explain proper operation of a distillation system, including operating problems.							●			●	●	
Discuss and understand material and energy balances, product composition and process disturbances during distillation.							●			●	●	
Describe, understand, and explain distillation principles, systems of azeotropic, extractive, and vacuum columns.							●			●	●	
Explain the principles of operation (heat transfer, air, fuel,water and steam flow), and types of boilers.							●			●	●	
Discuss and understand boiler's control systems and instrumentation, fuel systems and condensate and feedwater systems.							●			●	●	

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	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Understand procedures and operator's responsibilities during routine operations, boiler startup and shutdown, as well as boiler-related safety.							●				●	
Describe, understand, and explain design, principles of operation, components and troubleshooting of various types of reactors (stirred tank, tubular, and catalytic bed).							●				●	
Understand procedures and be able to perform operator's duties during reactor operation, startup and cooldown.							●				●	
Describe, understand, and explain design, principles of operation, components and troubleshooting of evaporator systems, their operation, startup and shutdown.							●				●	
Explain the principles of operation of refrigeration systems, including factors affecting operation.							●				●	
Understand refrigeration system controls and applications.							●				●	
Describe, understand, and explain principles of hydraulic system and applications such as pressure control valves, directional control valves, flow control, and hydraulic actuators and motors, including operator's responsibilities regarding these systems.							●				●	

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Describe, understand, and explain design, principles of operation, types, components and troubleshooting of mixers, including operator's responsibilities and mixer-related safety.							●				●	
Describe, understand, and explain design, principles of operation of various types of extraction systems.							●				●	
Explain the principles of operation (heat transfer, air, fuel flow), types of furnaces, their instrumentation and control, startup, routine operation, shutdown, troubleshooting, and operator responsibilities.							●				●	
Describe, understand, and explain the role of filtering and screening, types of filters and screens, their operations and operator responsibilities.							●				●	
Understand and explain water and wastewater chemical and mechanical treatment, including operator responsibility.							●				●	
Understand and apply proper lubrication, including seals, packing, oils, greases, solid lubricants.							●				●	
Understand the concept of process safety management program and its elements, including employee involvement and process safety information.								●				

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	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Understand and implement typical standards and regulations for chemical and related industries including PSM, EPA regulations, Clean Air Act, fugitive emissions regulations, HazCom, HazWoper, ISO 9000 and SARA regulations.							●	●			●	●
Understands and can operate with consideration for safety conditions for personnel, unit and community.							●	●			●	●
Understands and can follow permit, lockout/tagout, and confined space procedures, and perform startups, and shutdowns.							●	●			●	
Understands principles of operation and can use emergency equipment such as gas analyzers, respirators, and fire protection equipment.								●				●
Can use personal protective gear, safety tools and equipment.								●				●
Understands safety issues in fire prevention and material handling.							●	●			●	●
Understand chemical dependency issues as related to job performance.												
Understand and utilize basic statistical concepts.							●				●	
Understand and describe quality improvement techniques							●				●	

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Collect and interpret written and oral data, perform scheduled readings, and complete product sample and lab analysis reports and unit logs.							●	●				
Utilize and apply control charts for variables, SPC techniques for variables including continuous and batch processes and short run SPC.							●	●				
Understand and discuss fundamental concepts of variation and probability							●	●				
Apply and utilize control charts for attributes							●	●				
Use lot-by-lot acceptance sampling by attributes												
Apply acceptance sampling plan systems												
Understand and utilize concept of reliability												
Understand and analyze quality costs												
Be aware of computer applications in quality control												
Become familiar with the concept and practical applications of Total Quality Management												
Develop good organizational, communication, creative thinking, and problem-solving skills.							●	●			●	●
Acquire the ability to work as a team member, interact with internal and external customers, and to be self-motivated.							●	●			●	●

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Develop ability to prepare written reports and give oral presentations using visual aides when needed.							●	●			●	●
Is able to coordinate and communicate his/her actions with others							●	●			●	●
Understands the issues of quality management							●	●			●	●

Project #55110005

Chemical Operations Technology - Curriculum Development Project

Texas State Technical College - East Texas Center

PY95 Project Product:

Chemical Operations Technology

Curriculum Development Project

August 1995

Submitted to:

The Texas Higher Education Coordinating Board

TEXAS HIGHER EDUCATION COORDINATING BOARD
PY 95 END OF REPORT
JULY 1, 1994 - JUNE 30, 1995

EXECUTIVE SUMMARY

Texas State Technical College - Marshall — Institution
55110005 — Project Number

PROJECT TITLE: Chemical Operations Technology - Curriculum Development
PROJECT DIRECTOR: Alex Kajstura

1. Purpose of the project:

To develop a model curriculum for the Associate of Applied Science Degree in Chemical Operations Technology in both four-semester and six-quarter format, with inclusion of Statistical Process Control and Process Safety Management competencies.

2. Summary of Goals and Objectives Accomplished:

Objective A: A comprehensive analysis of the local and statewide labor market demand for trained personnel in the advanced field of Chemical Operations Technology (COT) has been conducted. The Project Advisory Committee was formed to coordinate this effort.

Objective B. A comprehensive task analysis was conducted and competencies required for COT were identified. Program objectives were stated as occupational competencies and/or skill and knowledge requirements and were based on results of comprehensive task surveys. Related occupational competencies were grouped into courses.

Objective C. The curriculum has been developed. It includes course descriptions, course sequence, weekly lecture and laboratory hours, contact hours, and credit hours for all courses. This curriculum was developed in both the semester and quarter formats for potential use by any two-year college in the State.

SUBCONTRACTORS: none

CONSULTANTS: William Hansen

COORDINATING AGENCIES: none

PRODUCTS: Curriculum Handbook

CHEMICAL OPERATIONS TECHNOLOGY

1. Curriculum in a Quarter Format
2. Course Descriptions for Quarter Format
3. Curriculum in a Semester Format
4. Course Descriptions for Semester Format
5. Competencies and Courses Matrix

CHEMICAL OPERATIONS TECHNOLOGY

1. Curriculum in a Quarter Format

CHEMICAL OPERATIONS TECHNOLOGY CURRICULUM
(QUARTERS)

FIRST QUARTER		LEC	LAB	CR
CHT 120	General Chemistry I	4	6	6
CHT 122	Chemical Calculations I	3	3	4
ENGL 1301	Composition I	4	0	3
MATH 1314	College Algebra	4	0	3
		13	12	16
SECOND QUARTER				
CHT 124	General Chemistry II	4	6	6
CHT 204	Chemical Calculations II	3	3	4
CHT 116	Intro. to Chem. Industry and Operations	3	3	4
MATH 1316	Plane Trigonometry	4	0	3
		14	12	17
THIRD QUARTER				
ENGL 134	Interpersonal Communications	4	0	3
	General Educ. PSYC or SOC	4	0	3
MTH 202	Basic Statistics and SPC	3	3	4
PHYS 1401	College Physics	4	4	4
		15	7	14
FOURTH QUARTER				
PSYC 1316	Critical Thinking and Problem Solving	4	0	3
CNS 2060	Applications Software	1	4	3
CHT 230	Chemical Industry Stds. and Regs.	3	3	4
CHT 260	Instrumentation and Control I	3	3	4
		13	10	14
FIFTH QUARTER				
CHT 270	Instrumentation and Control II	3	3	4
CHT 320	Process Equipment Operations I	3	3	4
CHT 350	Plant Operations and Systems I	3	3	4
OSH 112	Process Operations Safety	3	3	4
		15	12	16

SIXTH QUARTER

CHT 280	Instrumentation and Control III	3	3	4
CHT 330	Process Equipment Operations II	3	3	4
CHT 360	Plant Operations and Systems II	3	3	4
OSH 212	Environmental Health	2	3	3
	Free Elective	4	0	3
		15	12	18
	TOTAL	84	71	100

2. Course Descriptions for Quarter Format

CHT 116 Introduction to Chemical Industry and Operations (3-3-4).

A study of the development and industrial prominence of the chemical industry in Texas and United States. Opportunities for technician in the industry are spotlighted. Industrial films and visits are used extensively to illustrate the scope of chemical production. Most typical chemical processes in industry are presented.

CHT 120 General Chemistry I (4-6-6).

Basic principles are introduced. Emphasis is placed on fundamental laws, atomic structure, bonding, acids and bases, periodic classification of elements and solutions.

CHT 124 General Chemistry II (4-6-6).

Continuation of CHT 120. Covers molecular structures, thermodynamics, kinetics, chemical equlibria, nuclear chemistry and electrochemistry.
Prerequisite:CHT 120.

CHT 230 Chemical Industry Standards and Regulations (3-3-4).

Presentation and interpretation of typical standards and regulations for chemical and related industries including Plant Safety Management (PSM), EPA regulations, Clean Air Act, Fugitive Emissions regulations, HazCom, HazWoper, ISO 9000, and SARA regulations.

CHT 260 Instrumentation and Control I (3-3-4)

The purpose of this course is to provide introduction to instrumentation and control as it applies to process system measurement. Commonly measured process variables are identified and techniques of their measurement are discussed. Description of the

operating principles used to measure and indicate pressure, temperature, level and flow are provided.

CHT 270 Instrumentation and Control II (3-3-4).

This more advanced course introduces instrument systems and their application to measure and control process variables. Basic process control methods such as feedback and feedforward, as well as process dynamics are presented. Students also learn to read, interpret, and use P&ID, flow, and electrical diagrams.
Prerequisite:CHT 260

CHT 280 Instrumentation and Control III (3-3-4).

This most advanced instrumentation and control course describes and explains process control systems and several types of control mode operations, including two-position, proportional, and PID control. Control loops, PLCs, information displays are introduced as components od digital control systems. The course discusses also Distributed Control Systems including discrete, continuous, batch and numerical control systems.
Prerequisite:CHT 270

CHT 320 Process Equipment Operations I (3-3-4).

This course introduces students to the major types of equipment used in industrial facility. Equipment such as various valves, piping, protective devices, and their operations are discussed. Operations of industrial steam traps, heat exchangers, cooling towers, condensers, reboilers are discussed. Electrical distribution, hydraulic, and emergency systems are introduced and their components are presented.

CHT 330 Process Equipment Operations II (3-3-4).

A continuation of CHT 320, this course allows students to become familiar with the purpose and use of other equipment commonly used in various industries such as screens and filters, couplings, drives, pumps, steam turbines, compressors, and refrigeration systems. Students learn the principles of operation and factors affecting operation.

Prerequisite:CHT 320

CHT 350 Plant Operations and Systems I (3-3-4).

A study of operations of various systems and processes found in chemical and related plants, such as distillation, distillation tower, azeotropic, extractive, and vacuum columns operations, liquid-liquid solid extraction, evaporation units operations. Introduction to gas chromatography is included.

CHT 360 Plant Operations and Systems II (3-3-4).

This course is a continuation of CHT 350 and includes study of other systems and devices being system components such as reactors, mixers, boilers, fans, furnaces, and water treatment systems.
Prerequisite:CHT 350

MTH 202 Basic Statistics and Statistical Process Control (3-3-4).

This course covers basic statistical concepts such as probability, sampling, correlation, variation, analysis of variance. This course also introduces student to SPC and its applications to the process. SPC concepts such as control charts, out-of-control processes, patterns of instability, trend indications, warning line and control limit violations, cycling and overcontrol, and CUSUM are introduced.
Prerequisite:Math 1314

OSH 112 Process Operations Safety (2-3-3).

A course to cover basic principles used to establish safe control measures for work with industrial chemicals. Process Safety Management program and its elements are discussed. Permit, lockout/tagout, and confined space procedures are explained. Use of personal protective gear, safety tools, and fire prevention is presented.
Prerequisite: CHT 102 or CHT 120

OSH 212 Environmental Health (2-3-3).

An introductory study dealing with the recognition and evaluation of hazards in the workplace environment. Air contamination detection instruments will be studied as well.

ENGL 1301 Composition I (4-0-3).

Students study the process of composing essays, including prewriting techniques, drafting, and revising and editing. Students write several multi-paragraph essays of different types, in both in-class and out-of-class settings. students critically analyze sample student and professional essays.

ENGL 134 Interpersonal Communication (4-0-3).

Theories and exercises in verbal and nonverbal communication with focus on interpersonal relationships. Students will study internal and external factors that impact communication, communication clarification, and conflict resolution.
Prerequisite: ENGL 1301

MATH 1314 College Algebra (4-0-3).

A study of quadratics, polynomial, rational, logarithmic and exponential functions, systems of equations, progressions, sequences and series, matrices and determinants.

MATH 1316 Trigonometry (4-0-3).

Topics in trigonometric functions, right triangles, trigonometric identities, radian measure, graphs of periodic functions, and oblique triangles.
Prerequisite: MATH 1314.

PHYS 1401 College Physics (4-4-4).

This course is for students who need a technical course ion physics. This course includes mechanics, dynamics, heat, and sound. Emphasis is on fundamental concepts, their applications and problem solving.

CNS 2060 Applications Software (1-4-3).

A course includes introductory concepts combined with an emphasis on more predominate computer software including but not limited to DOS, wordprocessing, spreadsheets, and databases providing students with computer literacy and ability to meet basic computer requirements at work.

3. Curriculum in a Semester Format

CHEMICAL OPERATIONS TECHNOLOGY CURRICULUM
(SEMESTERS)

		LEC	LAB	CR
FIRST SEMESTER				
CHEM 1411	General Chemistry I	3	3	4
ENGL 1301	Composition I	3	0	3
	General Educ. PSYC or SOC	3	0	3
COSC 1301	Computer Applications	2	2	3
MATH 1314	College Algebra	3	0	3
		14	5	16
SECOND SEMESTER				
CHEM 1412	General Chemistry II	3	3	4
ENGL 2303	Interpersonal Communications	3	0	3
CHEM 1316	Intro. to Chem. Industry and Operations	2	2	3
PSYC 1316	Critical Thinking and Problem Solving	3	0	3
MATH 1316	Plane Trigonometry	3	0	3
		14	5	16
THIRD SEMESTER				
MATH 1402	Basic Statistics and SPC	2	2	3
	Free Elective	3	0	3
CHT 230	Chemical Industry Stds. and Regs.	2	2	3
INT 2401	Instrumentation and Control I	3	3	4
PHYS 1401	College Physics	3	3	4
		13	10	17
FOURTH SEMESTER				
OSH 212	Environmental Health	2	2	3
INT 2402	Instrumentation and Control II	3	3	4
CHT 320	Process Equipment Operations	3	3	4
CHT 350	Plant Operations and Systems	3	3	4
OSH 112	Process Operations Safety	2	2	3
		15	12	18
	TOTAL	56	32	67

Course Descriptions in the Semester Format

CHT 1316 Introduction to Chemical Industry and Operations (3-0-3).

A study of the development and industrial prominence of the chemical industry in Texas and United States. Opportunities for technician in the industry are spotlighted. Industrial films and visits are used extensively to illustrate the scope of chemical production. Most typical chemical processes in industry are presented.

CHEM 1411 General Chemistry I (3-3-4).

Basic principles are introduced. Emphasis is placed on fundamental laws, atomic structure, bonding, acids and bases, periodic classification of elements and solutions.

CHEM 1412 General Chemistry II (3-3-4).

Continuation of CHEM 1401. Covers molecular structures, thermodynamics, kinetics, chemical equlibria, nuclear chemistry and electrochemistry.
Prerequisite:CHEM 1411.

CHT 230 Chemical Industry Standards and Regulations (2-2-3).

Presentation and interpretation of typical standards and regulations for chemical and related industries including Plant Safety Management (PSM), EPA regulations, Clean Air Act, Fugitive Emissions regulations, HazCom, HazWoper, ISO 9000, and SARA regulations.

INT 2401 Instrumentation and Control I (3-3-4).

The purpose of this course is to provide introduction to instrumentation and control as it applies to process system measurement. Commonly measured process variables are identified and techniques of their measurement are discussed. Description of the

operating principles used to measure and indicate pressure, temperature, level and flow are provided. Students also learn to read, interpret, and use P&ID, flow, and electrical diagrams.

INT 2402 Instrumentation and Control II (3-3-4).

This more advanced course introduces instrument systems and their application to measure and control process variables. Basic process control methods such as feedback and feedforward, as well as process dynamics are presented. The course describes and explains process control systems and several types of control mode operations, including two-position, proportional, and PID control. Control loops, PLCs, information displays are introduced as components od digital control systems. The course discusses also Distributed Control Systems including discrete, continuous, batch and numerical control systems.

Prerequisite: INT 2401.

CHT 320 Process Equipment Operations (3-3-4).

This course introduces students to the major types of equipment used in industrial facility. Equipment such as various valves, piping, protective devices, and their operations are discussed. Operations of industrial steam traps, heat exchangers, cooling towers, condensers, reboilers are discussed. Electrical distribution, hydraulic, and emergency systems are introduced and their components are presented. Students become familiar with the purpose and use of other equipment commonly used in various industries such as screens and filters, couplings, drives, pumps, steam turbines, compressors, and refrigeration systems. Students learn the principles of operation and factors affecting operation.

CHT 350 Plant Operations and Systems (3-3-4).

A study of operations of various systems and processes found in chemical and related plants, such as distillation, distillation tower, azeotropic, extractive, and vacuum columns operations, liquid-liquid solid extraction, evaporation units operations. Introduction to other systems and devices being system components such as reactors, mixers, boilers, fans, furnaces, and water treatment systems.

MTH 202 Basic Statistics and Statistical Process Control (3-3-4).

This course covers basic statistical concepts such as probability, sampling, correlation, variation, analysis of variance. This course also introduces student to SPC and its applications to the process. SPC concepts such as control charts, out-of-control processes, patterns of instability, trend indications, warning line and control limit violations, cycling and overcontrol, and CUSUM are introduced.
Prerequisite:Math 1314

OSH 112 Process Operations Safety (2-2-3).

A course to cover basic principles used to establish safe control measures for work with industrial chemicals. Process Safety Management program and its elements are discussed. Permit, lockout/tagout, and confined space procedures are explained. Use of personal protective gear, safety tools, and fire prevention is presented.
Prerequisite: CHT 102 or CHT 120.

OSH 212 Environmental Health (2-2-3).

An introductory study dealing with the recognition and evaluation of hazards in the workplace environment. Air contamination detection instruments will be studied as well.

ENGL 1301 Composition I (3-0-3).

Students study the process of composing essays, including prewriting techniques, drafting, and revising and editing. Students write several multi-paragraph essays of different types, in both in-class and out-of-class settings. students critically analyze sample student and professional essays.

ENGL 134 Interpersonal Communication (3-0-3).

Theories and exercises in verbal and nonverbal communication with focus on interpersonal relationships. Students will study internal and external factors that impact communication, communication clarification, and conflict resolution.
Prerequisite: ENGL 1301

MATH 1314 College Algebra (3-0-3).

A study of quadratics, polynomial, rational, logarithmic and exponential functions, systems of equations, progressions, sequences and series, matrices and determinants.

MATH 1316 Trigonometry (3-0-3).

Topics in trigonometric functions, right triangles, trigonometric identities, radian measure, graphs of periodic functions, and oblique triangles.
Prerequisite: MATH 1314.

PHYS 1401 College Physics (3-3-4).
This course is for students who need a technical course ion physics. This course includes mechanics, dynamics, heat, and sound. Emphasis is on fundamental concepts, their applications and problem solving.

COSC 1301 Computer Applications (2-2-3).

A course includes introductory concepts combined with an emphasis on more predominate computer software including but not limited to DOS, wordprocessing, spreadsheets, and databases providing students with computer literacy and ability to meet basic computer requirements at work.

SIX-QUARTER CURRICULUM MATRIX

	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Perform addition, subtraction, multiplication, division, operations on fractions and signed numbers, and conversions	●	●		●	●	●				●	●
Calculate percentages, ratios and proportions, powers and roots	●	●		●	●	●				●	●
Understand and perform solving linear equations, systems of equations and algebraic fractions	●	●		●	●	●				●	●
Can utilize graphical methods and interpret graphs	●	●		●	●	●				●	●
Perform operations with exponents	●	●		●	●	●				●	●
Understand fundamental concepts of matter, compounds, and mixtures, as well as physical and chemical properties	●	●			●	●	●				
Understand and explain types of chemical reactions and stoichiometry (material and energy balance, limiting factors)	●	●			●	●					
Understand and apply process chemistry concepts such as stoichiometry, reaction rates, catalysts, and chemical equilibrium	●	●			●	●					
Define, prepare and use various solutions including required calculations	●	●			●	●					
Understand fundamental concepts of organic chemistry, including groups of organic compounds, their physical and chemical properties	●	●			●	●	●				

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	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Define, prepare and use various solutions including required calculations.	●	●			●	●					
Define and explain solution-related characteristics such as concentration, rate, crystallization, liquid extraction, absorption, adsorption, and leaching.											
Understand fundamental concepts of organic chemistry, including groups of organic compounds, their physical and chemical properties.											
Define, understand, and explain inorganic process reactions such as ionization, redox, neutralization	●				●						
Define, understand, and explain organic process reactions such as alkylation, halogenation, and polymerization					●						
Understand, describe, and explain scientific principles, laws, and units as applied to process system operation, force, motion, work, heat transfer, mechanics, and fluid dynamics	●	●			●	●					●
Describe and understand the physical properties of solids, liquids, gases	●	●			●	●					●
Explain specific heat, latent heat, heat transfer, and apply these to heat exchangers	●	●			●	●					●
Describe and understand basic principles and effect of pressure and energy in fluid systems.											●

	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Understand and implement typical standards and regulations for chemical and related industries including PSM, EPA regulations, Clean Air Act, fugitive emissions regulations, HazCom, HazWoper, ISO 9000 and SARA regulations.											
Understands and can operate with consideration for safety conditions for personnel, unit and community.											
Understands and can follow permit, lockout/tagout, and confined space procedures, and perform startups, and shutdowns.											
Understands principles of operation and can use emergency equipment such as gas analyzers, respirators, and fire protection equipment.											
Can use personal protective gear, safety tools and equipment.											
Understands safety issues in fire prevention and material handling.											
Understand chemical dependency issues as related to job performance.											
Understand and utilize basic statistical concepts.										●	
Understand and describe quality improvement techniques.										●	

	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Collect and interpret written and oral data, perform scheduled readings, and complete product sample and lab analysis reports and unit logs										●	
Utilize and apply control charts for variables, SPC techniques for variables including continuous and batch processes and short run SPC										●	
Understand and discuss fundamental concepts of variation and probability										●	
Apply and utilize control charts for attributes										●	
Use lot-by-lot acceptance sampling by attributes										●	
Apply acceptance sampling plan systems										●	
Understand and utilize concept of reliability										●	
Understand and analyze quality costs										●	
Be aware of computer applications in quality control										●	
Become familiar with the concept and practical applications of Total Quality Management										●	
Develop good organizational, communication, creative thinking, and problem-solving skills	●				●				●	●	
Acquire the ability to work as a team member, interact with internal and external customers, and to be self-motivated	●				●				●		●

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	CHT 120	CHT 122	ENGL 1301	MATH 1314	CHT 124	CHT 204	CHT 116	MATH 1316	ENGL 134	MTH 202	PHYS 1401
Develop ability to prepare written reports and give oral presentations using visual aides when needed.	●				●		●		●	●	
Is able to coordinate and communicate his/her actions with others	●				●						
Understands the issues of quality management										●	

SIX-QUARTER CURRICULUM MATRIX

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Perform addition, subtraction, multiplication, division, operations on fractions and signed numbers, and conversions.				●	●				●			
Calculate percentages, ratios and proportions, powers and roots.				●	●				●			
Understand and perform solving linear equations, systems of equations and algebraic fractions.				●	●				●			
Can utilize graphical methods and interpret graphs.				●	●				●			
Perform operations with exponents.				●	●				●			
Understand fundamental concepts of matter, compounds, and mixtures, as well as physical and chemical properties.												
Understand and explain types of chemical reactions and stoichiometry (material and energy balance, limiting factors).												
Understand and apply process chemistry concepts such as stoichiometry, reaction rates, catalysts, and chemical equilibrium.												
Define, prepare and use various solutions including required calculations.												
Understand fundamental concepts of organic chemistry, including groups of organic compounds, their physical and chemical properties.												

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Define process instrumentation and process variables and demonstrate knowledge of instrument reading techniques.				●	●				●			
Describe design, principles of operation, and applications of common pressure, emperature, level, and flow measuring and indicating instruments.				●	●				●			
Define and explain analytical measurement and identify common analytical variables.				●	●				●			
Explain the operation and use of instruments such as pH meter, oxygen meter, hydrometers, colorimeters, turbidity meters, opacity meters, and psychrometers.				●	●				●			
Explain the function and operation of instrument system devices such as transmitters, transducers, recorders, indicators, controllers, and final control elements.				●	●				●			
Identify, define, and explain the purpose, operation, and types of process control systems such as feedback/feedforward control, two-position, proportional, reset, rate, and PID control.				●	●				●			
Describe and explain the control action generated by various process control modes.				●	●				●			
Describe digital control systems, including analog and digital instrument systems, data acquisition, and control loops.				●	●				●			

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	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Explain the functions of programmable controllers, microprocessors, computers, and distributed control systems in process facilities.					●				●			
Describe and explain principles of operation, types, system components, applications, and troubleshooting of heat exchangers.						●	●			●	●	
Describe the operations, design, and chemical treatment of cooling water systems.						●	●			●	●	
Describe and understand principles of operation, design, troubleshooting, and applications of positive displacement, and centrifugal pumps.						●	●			●	●	
Have the knowledge of pump auxiliaries, such as drivers, couplings, strainers, lubricating, cooling and sealing system.						●	●			●	●	
Understand and perform an inspection of an operating pump.						●	●			●	●	
Have a detailed knowledge of single-stage and multistage centrifugal pumps, parts and functions, and their startup and shutdown procedures.						●	●			●	●	
Describe principles of operation, design, and applications of reciprocating and rotary pumps, their startup and shutdown procedures.						●	●			●	●	
Describe and explain purposes, types, and principles of operation of hand and automatic valves.						●	●			●	●	

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Understand and perform specific operator's responsibilities regarding hand and automatic valves and response to their failure.						●	●			●	●	
Describe and explain principles of operation, components, types and applications of gas compressors and their auxiliaries.						●	●			●	●	
Have the knowledge of compressor instrumentation and controls, startup and shutdown procedures, operational checks, problems and corrective actions, and compressor safety.						●	●			●	●	
Describe and explain principles of operation, applications, components of steam turbines and their auxiliary devices and systems.						●	●			●	●	
Describe and explain principles of operation, applications, components of steam turbines and their auxiliary devices and systems.						●	●			●	●	
Describe, understand, and explain design, types, principles of operation, components, controls, troubleshooting, operations, and safety of induced and forced draft fans.						●	●			●	●	
Describe basic concepts and use of system diagrams such as flow diagrams and Piping and Instrumentation (P&ID) diagrams.										●	●	
Describe the basic operation, components, and power transmission in electrical systems.				●	●				●	●		

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Describe the operation of AC and DC motors, energy conversion, and motor controllers and control circuits.						●	●			●	●	
Describe, understand, and explain distillation principles, systems, types of towers, and equipment.						●	●			●	●	
Understand the tower operating conditions and how they affect the process.							●			●	●	
Become proficient in the distillation process startup and shutdown procedures, including checks and problems.							●			●	●	
Describe, understand, and explain proper operation of a distillation system, including operating problems.							●			●	●	
Discuss and understand material and energy balances, product composition and process disturbances during distillation.							●			●	●	
Describe, understand, and explain distillation principles, systems of azeotropic, extractive, and vacuum columns.							●			●	●	
Explain the principles of operation (heat transfer, air, fuel,water and steam flow), and types of boilers.							●			●	●	
Discuss and understand boiler's control systems and instrumentation, fuel systems and condensate and feedwater systems.							●			●	●	

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	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Understand procedures and operator's responsibilities during routine operations, boiler startup and shutdown, as well as boiler-related safety.							●				●	
Describe, understand, and explain design, principles of operation, components and troubleshooting of various types of reactors (stirred tank, tubular, and catalytic bed).							●				●	
Understand procedures and be able to perform operator's duties during reactor operation, startup and cooldown.							●				●	
Describe, understand, and explain design, principles of operation, components and troubleshooting of evaporator systems, their operation, startup and shutdown.							●				●	
Explain the principles of operation of refrigeration systems, including factors affecting operation.							●				●	
Understand refrigeration system controls and applications.							●				●	
Describe, understand, and explain principles of hydraulic system and applications such as pressure control valves, directional control valves, flow control, and hydraulic actuators and motors, including operator's responsibilities regarding these systems.							●				●	

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Describe, understand, and explain design, principles of operation, types, components and troubleshooting of mixers, including operator's responsibilities and mixer-related safety.							●				●	
Describe, understand, and explain design, principles of operation of various types of extraction systems.							●				●	
Explain the principles of operation (heat transfer, air, fuel flow), types of furnaces, their instrumentation and control, startup, routine operation, shutdown, troubleshooting, and operator responsibilities.							●				●	
Describe, understand, and explain the role of filtering and screening, types of filters and screens, their operations and operator responsibilities.							●				●	
Understand and explain water and wastewater chemical and mechanical treatment, including operator responsibility.							●				●	
Understand and apply proper lubrication, including seals, packing, oils, greases, solid lubricants.							●				●	
Understand the concept of process safety management program and its elements, including employee involvement and process safety information.								●				

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	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Understand and implement typical standards and regulations for chemical and related industries including PSM, EPA regulations, Clean Air Act, fugitive emissions regulations, HazCom, HazWoper, ISO 9000 and SARA regulations.							●	●			●	●
Understands and can operate with consideration for safety conditions for personnel, unit and community.							●	●			●	●
Understands and can follow permit, lockout/tagout, and confined space procedures, and perform startups, and shutdowns.							●	●			●	
Understands principles of operation and can use emergency equipment such as gas analyzers, respirators, and fire protection equipment.								●				●
Can use personal protective gear, safety tools and equipment.								●				●
Understands safety issues in fire prevention and material handling.							●	●			●	●
Understand chemical dependency issues as related to job performance.												
Understand and utilize basic statistical concepts.							●				●	
Understand and describe quality improvement techniques.							●				●	

	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Collect and interpret written and oral data, perform scheduled readings, and complete product sample and lab analysis reports and unit logs							●	●				
Utilize and apply control charts for variables, SPC techniques for variables including continuous and batch processes and short run SPC							●	●				
Understand and discuss fundamental concepts of variation and probability							●	●				
Apply and utilize control charts for attributes							●	●				
Use lot-by-lot acceptance sampling by attributes												
Apply acceptance sampling plan systems												
Understand and utilize concept of reliability												
Understand and analyze quality costs												
Be aware of computer applications in quality control												
Become familiar with the concept and practical applications of Total Quality Management												
Develop good organizational, communication, creative thinking, and problem-solving skills							●	●			●	●
Acquire the ability to work as a team member, interact with internal and external customers, and to be self-motivated							●	●			●	●

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	PSYC 1316	CNS 2060	CHT 230	CHT 260	CHT 270	CHT 320	CHT 350	OSH 112	CHT 280	CHT 330	CHT 360	OSH 212
Develop ability to prepare written reports and give oral presentations using visual aides when needed							●	●			●	●
Is able to coordinate and communicate his/her actions with others							●	●			●	●
Understands the issues of quality management							●	●			●	●